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ELEMENTS

OF

NATURAL HISTORY

AND

CHEMISTRY.

By M. *FOURCROY;*

DOCTOR OF THE FACULTY OF MEDICINE AT PARIS, OF
THE ROYAL ACADEMY OF SCIENCES, &c.

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Names of CHEMICAL SUBSTANCES, with all the TABLES,
and a Complete INDEX.

To which is prefixed by the TRANSLATOR,

A PREFACE, containing Strictures on the Hiftory and prefent
State of CHEMISTRY; with Obfervations on the Pofitions,
Facts, and Arguments, urged for and againft the ANTIPHLO-
GISTIC THEORY, and the NEW NOMENCLATURE, by
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E L E M E N T S

OF

NATURAL HISTORY

AND

CHEMISTRY.

PART III. *continued.*

C H A P.   VII.

Of Vegetable Acids, formed by the Action of Fire, and by the Nitric Acid.

IT has been long known to chemifts, that many vegetable matters afford, by diftillation, phlegms, or acid liquors : thefe faline fubftances, altered by fire, were, however, but little attended to. Since fuch a number of acids have been difcovered, really diftinct from one another, either in their intimate nature, or in the proportion of their principles, many of thefe falts have been found to poffefs peculiar and diftinctive properties. It has been alfo afcertained that fome acids act, like heat, on vegetable matters, and that the nitric acid,

in particular, converts moſt of them into acids. Theſe
new, or newly modified ſalts, need to be carefully exa-
mined, in order that we may acquire a knowledge of
their nature. We cannot avoid remarking, in the firſt
place, that there muſt be a general analogy of nature,
or formation, among vegetable acids, produced by the
action of heat : On account of that analogy, we give
them the generic name of empyreumatic ſalts; and
apply to each of them, as a ſpecific diſtinction, the ſyl-
lable *pyro*, joined to a term indicating the origin of the
ſalt ; thus we ſay, the *pyro-tartareous*, the *pyro-mucous*,
and the *pyro-ligneous* acids.

§ I. *Of the Pyro-Tartareous Acid.*

IT has been already mentioned, that, by the diſtillation
of the tartareous acidulum, an acid phlegm is obtain-
ed, which is not the pure tartareous acid, but that acid
altered in a particular manner. The hydrogenous gas,
and the carbonic acid gas, that are, at the ſame time,
diſengaged, ſhew plainly that ſuch an alteration muſt
take place; for theſe can only be produced in conſe-
quence of the decompoſition of the acid of tartar. As
this alteration is owing to the action of heat, and as an
oil, mixed with the diſtilled acid, is at the ſame time
volatilized, which modifies its colour, we have there-
fore called that acid the *pyro-tartareous*, and its ſaline
combinations *pyro-tartarites*, according to the laws of
our nomenclature.

The firſt chemiſts who made experiments on this
matter with any degree of accuracy, aſcertained, that,
by diſtilling about a quarter of a pound of tartar, there
might be obtained an acid phlegm of a very pungent
                                                    ſmell,

fmell, or pyro-tartareous acid. The academicians of Dijon reprefent the fecondary rectification or diftillation of this acid, which has been recommended by fo many authors, as attended with one very great difficulty :— notwithftanding every precaution which they could a-dopt to moderate the fire, and give room to the va-pours, they always found the liquid to rife fo quickly as to burft the veffels containing it into pieces. This phe-nomenon they attribute to the action of gas produced by the decompofition of the acid, and compreffed by the oil ; which preffure it at length overcomes, as it is more dilated. Befides, the rectification is not very ne-ceffary, as the acid feparated from the oil by the ftill-pipe, is fo pure as to exhibit all its diftinctive characte-riftics.

The pyro-tartareous acid has an empyreumatic tafte and fmell. It does not redden violets, but it produces that effect on turnfole and blue paper : It difengages the carbonic acid from its bafes with a lively effervefcence. With the earths and alkalis it forms falts very different from thofe which the tartareous acid forms with the fame bafes. Thefe faline compounds have not yet been examined ; only, we know the pyro-tartarites of potafh and foda to be foluble in cold water, and cryftallizable : the acid decompofes nitrate of filver, producing from it a grey precipitate ; it by degrees renders nitrate of mercury turbid ; it does not decompofe calcareous mu-riate ; and the fulphuric acid decompofes its neutral falts by diftillation.

Chemifts, before hydrogene, carbonaceous matter, and oxigene, were underftood to be the fole and genu-ine component principles of all vegetable acids, confti-tuting different acids, only by being united in different proportions, had adopted opinions very remote from the

truth,

truth, concerning the nature of this acid, obtained by distillation from tartar. Venel asserted it to be acid of nitre. M. Monnet concluded, from a more accurate investigation of its nature, that it was muriatic acid disguised by oil and mucilage. But, although Scheele found tartar to contain a little muriatic acid, yet the cubic form of the neutral salt produced by the union of the pyro-tartareous acid with soda, and the precipitation of nitrate of mercury by this acid, the two facts on which M. Monnet establishes the identity of the pyro-tartareous with the muriatic acid, are not sufficient evidence to induce modern chemists to assent to the conclusion deduced from them. Besides, the chemists of Dijon have repeated the same experiments without obtaining the same results; nor have Messrs Berthollet, Spielman, and Corvinus, been more successful. On the contrary, it is highly probable, that the principles of the pyro-tartareous acid, are the same with those of the acid of tartar itself; and that the two acids differ only in the proportion of their principles : the smell and taste of this empyreumatic acid, its not being susceptible of crystallization, and all its other properties, and still more, the disengagement of oil and carbonic gas from the tartareous acidulum, when the pyro-tartareous acid is formed,—concur to prove the truth of what is here asserted.

The character of this empyreumatic acid has not yet been sufficiently investigated, to enable us to determine the order of its chemical affinities with earthy, alkaline, and metallic bases.

§ II.

§ II. *Of the Pyro-Mucous Acid.*

THE acid which we denominate Pyro-mucous, is that obtained from infipid, faccharine, gummy, farinaceous, &c. mucilages, which was, at firft, denominated by M. de Morveau, the fyrupous acid. Chemifts have long known that fugar affords, by diftillation, a pretty ftrong acid phlegm. Neuman, Cartheufer, Geoffroy, and Bucquet have made particular mention of that acid, but without having examined its properties. M. Schrickel has examined its nature with more minute attention than any other chemift.

By diftilling 16 ounces of fugar, M. Schrickel obtained 6 drachms of phlegm, which paffed into the receiver in the form of white vapour, and was condenfed into unctuous ftriæ, of a pungent fmell, like that of horferadifh, or bitter almonds, roafted; of an acid, acrid, and bitter tafte, and of a red yellow colour. He rectified this acid upon clay; it then paffed clear, with a lefs pungent fmell, and a four tafte. This acid, when thus purified, did not cryftallize: but when expofed to cold, the aqueous part froze, and that part which ftill remained liquid became much more concentrated.

M. de Morveau obferved, when preparing the pyromucous acid by the diftillation of fugar, that the bottom of the retort was corroded during the operation. He does not attribute that to the acid, as it exhibits no fuch property, when rectified, or when left long in the glafs; but rather to the action and adhefion of the carbure of iron, which exifts in the coal that remains after the decompofition of the fugar, and had been violently heated. This acid, therefore, cannot be concentrated by volatilizing the water that is united with it, as the

A 3 falt

falt is no lefs volatile than the fluid. This acid, accord-
ing to M. Morveau, exifts in molaffes, and renders them
deliquefcent and not fufceptible of chryftallization.

The pyro-mucous acid, when concentrated by freezing,
is very pungent, and communicates a deep red to blue
vegetable colours. It produces red fpots on the fkin,
as was long ago obferved by Cartheufer ; and the fpots
thus produced, deftroy the epidermis before they difap-
pear. When expofed to fire, it is totally volatilized,
leaving no refidue, but a brown mark on the place
where it lay. Moft of it may be converted into car-
bonic acid gas, and hydrogenous gas, by diftilling it,
with proper precautions, in clofe veffels : it now affords
a more copious carbonaceous refidue than when heated
in open veffels. A part is volatilized without alteration.

When combined with barytes, magnefia, lime, potafh,
foda, and ammoniac, it forms neutral falts, which we
call *pyro-mucites*, the properties of which have not yet
been examined with fufficient care, but which differ
from all other known neutral falts. It difengages the
carbonic acid from all of thefe alkaline bafes with a
lively effervefcence.

The property of diffolving gold was formerly afcrib-
ed to the fpirit of honey ; but it appears for certain,
that the pyro-mucous acid does not affect either that
metal, or platina, or filver, or even mercury ; but it
might poffibly diffolve the oxides of thefe metals. This
acid corrodes lead, becoming opaque itfelf on the occa-
fion ; which alteration it owes to the oxide of lead which
it forms. Pyromucite of lead is in oblong cryftals. It
acts upon copper, and becomes green by the reaction of
that metal ; it diffolves tin ; it acts upon iron, and com-
bines with that metal to form cryftals.

Its

The pyro-ligneous acid may be alfo rectified by diftil-lation, according to M. Goettling. The pyro-lignite of potaſh, formed of this rectified acid, becomes very hot when brought into contact with the ſulphuric acid, and affords pyro-ligneous acid in a ſtate of conſiderable pu-rity. That chemiſt, to whom we are indebted for theſe facts, obſerves, that the pyro-ligneous acid, when ſepa-rated by the ſulphuric acid, has no longer an empyreu-matic odour, but a ſmell of garlic.

The chemiſts of Dijon extracted this acid from beech, by diſtillation, and afterwards rectified the liquid pro-duct : 55 ounces of this wood, well dried, and in ſhavings, afforded 17 ounces of rectified acid, of an amber colour, not mixed with oil, and of which the gravity was to that of diſtilled water in the proportion of 49 to 48 : $23\frac{1}{2}$ ounces of lime-water were required to ſaturate an ounce of this acid. When expoſed to a gentle heat, it aſcends in vapour. A ſtrong heat decompoſes this, as well as all other vegetable acids. It cannot be obtained in a concrete form.

It combines with earthy and alkaline baſes, and forms with them peculiar ſalts which we call pyro-lignites of aluminous earth, barytes, magneſia, lime, potaſh, ſoda, and ammoniac. Theſe ſalts have not yet been exa-mined with ſufficient care, to enable us to give here a particular account of them. M. Eloy Bourſier de Clervaux has communicated, in the Lectures of Chemiſtry of Dijon, ſome experiments very ſuitable to determine the elective attractions of the pyro-ligneous acid. Calcareous and barytic earths adhere to it with greater obſtinacy than the alkalis ; lime has a ſtronger affinity with it than ba-rytes ; and magneſia a ſtronger than ammoniac : and even theſe affinities may ſerve to diſtinguiſh it from moſt other

other vegetable acids. It acts alfo upon many of the metals, and diffolves moft of their oxides.

All kinds of wood, it appears, would afford the fame acid by diftillation ; for box, birch, and beech agree in affording one acid. But much enquiry and many experiments are neceffary, before we can be fully acquainted with the characteriftic properties of this acid.

§ IV. *Of Vegetable Acids, formed by the Nitric Acid.*

BERGMAN has proved, that the nitric acid converts fugar into an acid, which, being at firft thought peculiar and different from all others, was therefore called the Saccharine Acid. Scheele has fhown this falt to be precifely the fame with that which is, in part, neutralized by potafh, in falt of forrel : this very falt is therefore in every refpect the fame with the oxalic acid. Several modern chemifts, and efpecially M. Berthollet, have proved, that almoft all animal and vegetable matters afford this acid, when treated with the acid of nitre. It is therefore certain, that the bafe or radical principle of the oxalic acid exifts in a great many bodies, and, in general, in all bodies which have been formed by vegetation, or the functions of animal life. The nitric acid acts in an equal and uniform manner on all fuch fubftances ; it always gives up to them either more or lefs of its oxigene, and paffes into the ftate of nitrous acid, nitrous gas, or even azotic gas, according as it is deprived of a greater or a lefs proportion of its oxigene. As the bafe, or radical principle of the oxalic acid, is more or lefs copious in the various organic matters in which it is found, thefe matters afford more or lefs of this acid, when treated with nitric acid. At the fame time,

time, when the acid of nitre is decompofed by organic fubftances, together with nitrous or azotic gas, there is alfo difengaged a certain quantity of carbonic acid gas, which proves the organic matter to have loft a part of its carbonaceous fubftance, and, at the fame time, fhews the oxalic acid, thus produced, to contain lefs of that principle than the fubftance from which it is obtained. Since a number of vegetable acids, particularly the tartareous acid, &c. pafs into the ftate of oxalic acid, in confequence of being expofed to the action of nitrous acid; and fince carbonic acid is difengaged while this change takes place; it follows plainly, therefore, that all the vegetable acids have the fame radical principle, and differ only in their proportions of oxigene.

In the *Nouvelles de la Republique de Lettres* for the year 1785, No. 42, and 44, it was related, that M. Kofegarten, by diftilling nitric acid on camphor, eight times fucceffively, had obtained from that matter a concrete acid, in parallelipiped cryftals, of bitter tafte, and capable of reddening the tincture of violets and turnfole. That falt, according to this chemift, differs from oxalic acid, as being incapable of feparating lime from the muriatic acid. With potafh it forms a falt in regular hexagons; with foda, a falt in irregular cryftals; with ammoniac, prifmatic or needled cryftals; with magnefia, a foluble, pulverulent falt. It diffolves copper, iron, bifmuth, zinc, arfenic, and cobalt. But thefe facts, which have not yet received confirmation, are not fufficient to enable us to enter into a minute account of the properties of this acid, which is, perhaps, nothing but a particular modification of fome one of thofe of which we have already fpoken. And if farther experiments on this acid fhall difcover it to poffefs peculiar properties, different from thofe of the other acids, its nature and
characteriftic

charaƈteriſtic properties muſt then be examined under the name of the camphoric acid, and its neutral ſalts will be called camphorates.

M. Brugnatelli diſcovered, in the year 1787, that cork, on which he diſtilled four times its own weight of nitrous acid, left a yellowiſh maſs, thick, acid, ſoluble in water, and of a four or rather a bitter taſte. This acid is not ſuſceptible of cryſtallization ; when evaporated by a ſtrong heat, it takes the form of a viſcous maſs, like wax, which is ſo ſoft that it may be moulded with the fingers. It is ſoluble in alcohol ; on burning coals it is reduced to a coal without inflammation ; with earths and alkalis it forms deliqueſcent ſalts, many of which cryſtal-lize : laſtly, it has as ſtrong an affinity with lime as the oxalic acid, and forms with that earth a ſalt that is not ſoluble in water, but may be diſſolved in muriatic acid. Without preſuming to ſpeak deciſively of the peculiar nature of this acid, M. Brugnatelli appears, however, to think it different from the oxalic acid. Future experi-ments muſt determine whether this be really a peculiar acid meriting a ſeparate examination ; and we muſt, in the ſame manner, leave the particular nature of that which has been diſcovered by Meſſrs Prouſt and Angulo, in the neighbourhood of Madrid, on the ſurfaces of grey peaſe, in veſiculæ at the extremity of the hairs of that leguminous plant, equally undetermined.

Thus we have given an account of all known vege-table acids. We have ſtill, however, to treat of thoſe which are formed by fermentation. But as the chief, nay, the only one of theſe acids that is known, is produ-ced in conſequence of an alteration taking place on li-quors that are already fermented, we will give its hiſtory immediately after that of ſpirituous fermentation, and its produƈt,

C H A P.

·C H A P. VIII.

Of Saccharine Matter, Gums, and Mucilages.

THE faccharine matter, which many chemifts think to be a fort of effential falt, is found in a great many vegetables, and is to be confidered as one of their immediate principles.—The maple, the birch, the red beet, the parfnip, the grape, wheat, &c. are found to contain it. Margraf extracted it from moft of thefe vegetables. The petals of many flowers, and the nectaria placed in thofe organs prepare a principle of this kind.

The fugar cane, *arundo faccharifera,* is the plant which contains the moft of it, and from which it is extracted with the greateft advantage. The fugar canes are crufhed to pieces between two iron cylinders, in a perpendicular pofition. The expreffed juice falls upon a plain furface underneath ; and is called *melaffes.* It runs off this furface into a boiler with afhes and lime, where it is boiled and fkimmed ; and, in the fame manner, it is fucceffively boiled and fkimmed in three other boilers; and, after undergoing thefe boilings, it receives the

name

name of fyrup. It is, after this, boiled anew, by a ftrong heat, and for a confiderable time, with lime and alum. After being fufficiently boiled and concentrated, it is poured into a veffel called *the cooler.* When it is fo cool that the finger may be dipped in it without injury, it is poured into large barrels ftanding over cifterns, and the bottoms of which are perforated with holes ftopped with canes. In the barrels, the fyrup takes the form of a folid mafs, part of it running off into the cifterns. The fugar, when thus rendered concrete, is yellow and unctu-ous; it is now called *mufcovado.* In the Sugar Iflands, it is refined by boiling it, and then pouring it fluid into inverted cones of earthen ware, called pans. That part which cannot be rendered concrete, runs through a hole in each of the pans, into a pot placed below : it is called *coarfe fyrup.* The bafe of the fugar-loaf is taken away, and white fugar in powder put into its place, and preffed well down : The whole is then covered with pure, moift clay. The water of the clay filtrates through the fu-gar, carrying off with it a portion of the mother water of the fugar, which runs out by the holes in the pans, and is received into new pots. This is called *fine fyrup,* as being purer than the former. A fecond layer of clay is laid on, when the firft becomes dry, and the water fil-trates through a fecond time : When the water con-tained in the fecond layer of clay is drained off, the loaves are removed into a ftove to dry. At the end of eight or ten days thefe loaves are broken, and fent into Europe in the form of brown fugar, where it is refined into fugar of different qualities.

The refining of fugar is accomplifhed by boiling it in lime-water, and with bullock's blood, fkimming it two or three times, filtrating the liquor, and running it in pans, to give it the fhape of loaves. Thefe loaves are then
coated

coated over with wet clay, the water of which is fuffered
to filtrate through them. The filtration is repeated with
frefh clay, till the fugar become fufficiently white. The
loaves are then removed into a ftove, and at the end of
eight days are wrapped up in paper for fale. The *fyrup*
which cannot be cryftallized is called *molaffes*.

Chemifts have univerfally been of opinion, that thefe
different operations feparated from fugar a fat matter,
and thereby rendered it fufceptible of cryftallization.
Bergman thinks, that the ufe which the lime ferves, is,
to carry off the excefs of acid, which hinders it from
taking a folid form. The acid can be no other than
the pyro-mucous acid which is formed by heat, as we
have related in the foregoing chapter. As the liquor is
expofed, during the operation, to a violent evaporation,
it becomes a granulated, irregular mafs, agreeably to
what has been already obferved of fulphate of zinc.

Sugar confifts of a peculiar acid, combined with a lit-
tle alkali, and altered by a good deal of oil, or greafy
matter. It cryftallizes in truncated, hexahedral prifms.
In this ftate it is called *fugar-candy*. It affords, by di-
ftillation, water, pyro-mucous acid, and a few drops of
empyreumatic oil. There is at the fame time difengaged
from it a confiderable quantity of carbonic acid gas, and of
hydrogenous gas, with coal diffolved in it. The refidue
is a fpongy, light coal, containing a little carbonate of
potafh.

Sugar is inflammable : When laid on burning coals,
it melts and fwells ; it exhales a very pungent acid va-
pour ; it takes a brown yellow colour, in confequence
of which it receives the name of *caramel*. It diffolves very
readily in water. It communicates to it a confiderable
confiftency, forming with it a fort of faccharine muci-
lage, which has received the name of *fyrup*. This fy-
rup,

rup, when diluted in water, is fufceptible of fermenta-
tion ; it may even be converted into a vinous liquor, and
alcohol diftilled from it.

Bergman prepared from all the different faccharine
matters, efpecially from fugar, oxalic acid by means of
the nitric acid. To obtain that acid from thefe matters,
put into a retort one part of fugar in powder, with fix
of nitric acid : Expofe the mixture to a moderate heat ;
continue the evaporation for fome time after red va-
pours ceafe to pafs ; leave the folution to cool ; and it
then precipitates white needled or prifmatic cryftals,
which are concrete oxalic acid.

Sugar is very much ufed.—It is an article of food which,
when taken in too large a quantity, heats the animal fyftem.
It is much ufed in pharmacy, being the bafis of fyrups,
lozenges, and fome other preparations. It contributes
to diffolve and fufpend in water, refins, oils, &c. It
ferves to preferve fruits reduced to jelly. It may be even
confidered as a medicine ; for it is incifive, aperitive,
and, in a flight degree, tonic and ftimulant : And accord-
ingly, there are fome inftances related, in which difor-
ders arifing from obftructions have been cured by the
continued ufe of fugar.

There are fome juices of plants which have a tafte of
fugar. Manna and nectar are of this kind. Manna is ob-
tained from the leaves of fir, oak, juniper, &c. and maple-
trees, &c. The afh, which is very plenteous in Calabria
and Sicilly, affords that which is commonly fold. It runs
naturally from thofe trees, but is obtained in ftill greater
abundance by making notches in the bark of the tree.—
That which is received on chips of wood, or fmall fticks
introduced into artificial apertures in the trees, takes the
form of hollow ftalactites, and is called *manna in tears.*
Manna in flakes runs down the bark, and contains fome
impurities,

impurities. The inferior unctuous fort contains many extraneous matters, and is formed from the refuse pieces of the two former. It is always humid, and frequently altered. The tafte of manna is mild and infipid : That which the larch tree that abounds in Dauphiny affords, and that of the alhagi, which grows in Perfia, around Mount Tauris, are not in ufe; the latter bears the name of *tereniabin*.—Manna is foluble in water; it affords, by diftillation, the fame products as fugar. There is extracted from it, by means of lime and white of eggs, a matter refembling fugar, which, when treated with the nitric acid, affords concrete oxalic acid.

It is given as a purgative, in dozes of from one to two or three ounces; or, when it is given as a difcuffive, a few drachms of it are diluted in a large proportion of water.

Another fort of proper juice, is that called *gum*, or *mucilage*. This fubftance is very plenteous in the vegetable kingdom. It is found in a great many roots: Young ftems and leaves, immediately after their appearance, contain a good deal of it. This principle may be known by its vifcous, adhefive property. In the feafon when the juice is moft copious, it runs naturally down the bark of trees, and thickens into gum on the furface. The gum is foluble in water, to which it communicates a thick, vifcid confiftency. This folution, known by the name of *mucilage*, becomes, when evaporated, dry, tranfparent, and friable.

Gum burns without emitting any perceptible flame.— It melts, and fwells upon coals. It affords, by diftillation, a good deal of water and pyro-mucous acid, a little thick brown oil, and carbonic acid gas, mixed with hydrogenous gas: The refidual coal is very bulky, and contains a little carbonate of potafh.

We

We know of three forts of gum that are used in medicine, and in the arts.

1. The gum of the apricot, the pear, and the plum-tree, &c. It is either white, yellow, or reddish; the best of this fort of gum may be applied to the fame purposes with the other gums. A kind of gummy juice, of a beautiful orange-colour, flows from the elm; considerable quantities of it are fometimes found on the bark of the tree. I have found this gum to poffefs the properties of infipidity, infolubility, vifcidity, with the other characteriftics belonging to fuch juices.

2. Gum Arabic, which runs from the acacia in Egypt and Arabia. Gum Senegal is of the fame kind; it is ufed in medicine as a mitigating and relaxing remedy. Crayons, and fome other fuch compofitions, are indebted to it for their confiftency. It is ufed in various arts.

3. Gum Adraganth, which flows from the adraganth of Crete; *Tragacantha Cretica.* It is adminiftered in the fame cafes as Gum Arabic; the folution of it is fomewhat thicker than the folution of Gum Arabic; it foon depofites vifcid flakes, and requires more water to diffolve it.

Mucilages, of the fame nature with gums, are obtained from various plants. The roots of mallows, marfhmallows, the greater comfrey, the bark of elm, lintfeed, the feeds of quinces, &c. afford, by maceration in water, vifcous fluids, which, when evaporated to drynefs, afford real gums. In medicine, decoctions of thefe plants are ufed inftead of folutions of gums.

All of thefe matters, chemically confidered, appear at firft view to be nearly fimple bodies; for chemical operations often offer to our obfervation fubftances of a gelatinous form, much like that of gums and mucilages; yet, from thefe products of vegetation, which appear to

form a fort of excrementitious humour, are extracted water, liquid pyro-mucous acid, carbonic acid, an oily principle, and fixed alkali united to a coaly refidue. This refidue likewife contains a fixed earth, the nature of which is ftill unknown.

When mucilages and gums are treated with nitric acid, and its action affifted by heat, they afford oxalic acid in cryftals. They contain therefore the oily or radical principle, which, in combination with oxigene, conftitutes this acid.

This analogy between mucilage and faccharine matter is farther obfervable, in that the fmell of burnt gum is much the fame with that of caramel—that the products which both afford by diftillation are of a fimilar nature—and that the bulk and levity of the refidual coal are the fame for both. Some of thofe fruits which become faccharine, fuch as apricots, pears, &c. exfude, when ripe, a real gum. That fort of dry mucilage which we are hereafter to examine under the name of *amylaceous fæcula*, is converted into faccharine matter by germination. Thefe facts, and many others which might be joined with thefe, fhew that there is a near relation between fugar and gum. Perhaps the infipid or gummy mucilage paffes by a fort of fermentation into the ftate of a faccharine body. Were this an afcertained fact, this fermentation would come in order before that which Boerhaave has called *fpiritous fermentation;* and muft conftantly precede it, both in the natural procefs of vegetation, and in the operations which art employs to produce the faccharine tafte in barley, &c.

CHAP.

C H A P. IX.

Of Oils of a fixed Nature, that are extracted by Expreſſion.

OILS are proper juices, of a fat, unctuous nature, either fluid or ſolid, not ſoluble in water, liable to burn with flame, volatile in various degrees: They are contained in the proper veſſels, or in particular veſiculæ. Theſe bodies are found exiſting in two ſtates in vegetables: They are either combined with other principles, as in extracts, mucilage, &c. or they are free, and not united with any other principle. Theſe latter oily juices are thoſe of which we are here to ſpeak.

Chemiſts have ſuppoſed the exiſtence of a ſimple oily principle, as well as of a primitive ſalt. This oily principle, combined with different ſubſtances, and modified by thoſe combinations, conſtituted, according to them, the various ſorts of oils that were obtained by analyſing vegetables. The characters which they aſcribed to that ſimple primitive oil were, great fluidity, an high degree of volatility, privation of colour and ſmell:—It burnt with flame and ſmoke:—It did not combine with water:

—It

—It was thought to confift of water and an acid combined with an earth and *phlogifton*. It is certain that oils, when decompofed, always afford a fmall quantity of acid, and a good deal of hydrogenous gas: earth conftitutes but a very fmall part of them, for they leave but very little fixed carbonaceous refidue. This notion of the oily principle deferves to be viewed only in the light of an hypothefis.

Oils are never formed by any but organic beings; and fuch bodies in the mineral kingdom as are of an oily nature, always owe their origin to the action of vegetable or animal life. It is even highly probable, that vegetables are the only bodies in which oils are formed; and that they pafs, without alteration, from vegetable into animal bodies.

The oily juices of vegetables are diftinguifhed into fixed oils, and volatile oils.

Fixed oils, called alfo *fat oils, fweet oils, oils by exprefsion,* are very unctuous: they have generally a mild and infipid tafte, and no fmell; the heat requifite to volatilize them is above that of boiling water; and they never take fire, till they are brought to that degree of heat which is requifite to volatilize them.—It is for this purpofe the wick ufed in burning fixed oil in lamps is employed; it heats the oil to volatilization.

Moft fixed oils are fluid, and require no confiderable degree of cold to render them folid: Others, again, lofe their fluidity by the flighteft cold; and, laftly, there are others always folid: Thefe laft are called, but very improperly, *vegetable butters.*

Fixed oils never flow from the furfaces of vegetables: They are contained in the kernels, the pippins, and emulfive feeds. They are extracted by bruifing the little

cells

cells in which they are contained; that is, by pounding and fqueezing.

Fixed oils, when expofed to the air, are altered, and become rancid; their acid is liberated; they lofe the properties which they poffeffed, and acquire others, in confequence of which they are nearly affimilated to volatile oils. Water and alcohol carry off the acid, and thus deftroy their rank tafte, but never reftore them to their primary ftate. M. Berthollet has difcovered, that fat oils, when expofed to air, by being thinly fpread over the furface of water, become thick, and affume pretty much the fame appearance with wax. It is at prefent known as an undeniable fact, that this thickening of oils is owing to their abforbing oxigene from the atmofphere; for all fubftances that contain this principle, and refign it to fixed oils,—as for inftance, many of the acids, efpecially the oxigenated muriatic acid, and metallic oxides,— thicken fixed oils, and reduce them to a ftate in which they refemble wax.

Fixed oils afford by diftillation a little water, containing a very acrid pungent acid, fome light oil, a thick oil, and a large quantity of hydrogenous gas mixed with carbonic acid: They leave but very little refidual coal. By diftilling thefe products a fecond time, pure febacic acid is obtained, of which we will have occafion to fpeak in the animal kingdom, and fome oil, ftill lighter than what was before obtained.—This oil is improperly called *philofopher's oil.* The alchemifts prepared it by diftilling, feveral times fucceffively, a brick impregnated with fixed oil. It is not perfectly known how far this decompofition may be carried: formerly, indeed, it was faid that a fixed oil might be reduced to a free inflammable principle; into water, acid, air, or earth.

Cold

Cold water effects no alteration on fat oils; it purifies them, by carrying off a part of their mucilage, which is likewife precipitated when they are fubmitted to combuftion, and is the principle that renders them fufceptible of fermentation, and liable to become rancid.—It is well known, that water caft upon thefe oils, when burning, inftead of quenching, caufes them to burn with new violence; the reafon of which is, that the water, being decompofed, fupplies oxigene to the oil, and at the fame time gives out a good deal of hydrogenous gas. When the vapour which proceeds from fixed oil in combuftion, is collected into a chimney terminating in a worm-pipe, a confiderable quantity is obtained; which proves this immediate principle of vegetables to contain hydrogenous gas.

Fixed oils do not combine with filiceous earth : With clay they form a foft pafte, which is employed in chemical manipulations under the name of *fat lute.*

They combine, by particular proceffes, with magnefia, and are thereby reduced to a faponaceous ftate.

Lime combines with them, but not in a very difcernible manner, when the combination is immediate. Pure alkalis combine eafily with fat oils, producing in this combination what is called *foap.*

In making foap, oil of olives or fweet almonds is triturated with a concentrated lixivium of foda, rendered cauftic by lime; and this preparation is known by the name of *foap-lye.*—In the courfe of a few days, the mixture becomes thick, and forms medicinal foap. Common foap is prepared by boiling the lixivium with altered oil; it is then white. Green foap is made up of the refufe of olives and potafh.

Soap diffolves in pure water : Heat decompofes it, difengaging from it phlegm, oil, and ammoniac formed in

                                                    confequence

consequence of the decomposition of the alkali and the fixed oil; the coaly residue contains a good deal of fixed alkali. This artificial composition of ammoniac seems to prove, that there is azote in the fixed alkali, which reacts upon the hydrogene of the oil.

Since water decomposes soap, as has been remarked by M. Thouvenel; an insoluble calcareous soap is then formed and deposited in small lumps. Acids poured on soap, disengage the oil, somewhat altered.

Ammoniac does not easily combine with fixed oils: however, by long trituration, the mixture acquires some degree of consistency, and becomes opaque.

Fixed oils combine with weak acids to form peculiar soaps. Messrs Achard, Cornette, and Macquer, have examined these compounds. M. Achard formed them by pouring slowly a quantity of concentrated sulphuric acid upon the fixed oil. By continued trituration, this mixture is formed into a brown mass, soluble in water and alcohol. The oil obtained from it by the intervention of alkalis, is always more or less concrete, as well as that obtained by distillation. Macquer advises to prepare this soap by pouring acid on the oil; but he informs us, that an acid soap, formed in this manner, is scarce soluble in water. That which is prepared of concentrated sulphuric acid, triturated with common alkaline soap, is more soluble. The concentrated sulphuric acid blackens fixed oils, and assimilates them to bitumens. This phenomenon seems to be produced by the reaction of the hydrogene of the oil on the oxigene of the acid.

The fuming nitrous acid, blackens fixed oils instantaneously, and causes such as are of a dry nature to kindle and emit a flame. Those, again, which cannot be so readily dried, require, to kindle them, a mixture of this acid with the acid of sulphur, as has been shown by

Rouelle,

Rouelle, the elder, in his Memoir on the Inflammation of Oils. *Academy, Year* 1747.

The muriatic and the carbonic acids act with but little ſtrength on fixed oils.—The former of theſe, however, in a concentrated ſtate, combines with them to a certain degree, according to M. Cornette. The oxigenated muriatic acid thickens them a good deal, and ſeems to make them paſs, by abſorbing their oxigene, into a ſtate in which they bear a great reſemblance to wax.

We know nothing of the action of the other acids on fixed oils. It appears that they do not combine with neutral ſalts. Several of theſe, and eſpecially all calcareous ſalts, decompoſe alkaline ſoap. In this inſtance of decompoſition, particularly when ſulphate of lime, or of magneſia, which is often found in union with waters, decompoſes this ſoap, the ſulphuric acid combines with the fixed alkali of the ſoap, and thereby forms ſulphate of ſoda ; the lime or magneſia combines with the oil, and produces a ſort of ſoap that is ſcarce ſoluble, and ſwims in whitiſh lumps on the ſurface of the water. This is the cauſe of the common appearance produced by hard waters, which curdle ſoap, but do not diſſolve it.

The action of hydrogenous gas on fixed oils has not yet been examined.

Theſe oils diſſolve ſulphur, when their action is aſſiſted by a boiling heat. The ſolution is of a dark red colour, inclining to brown. It has a very fœtid ſmell. It depoſites, by degrees, ſulphur in cryſtals. On diſtilling this combination, the ſulphur is volatilized, being ſo completely diſſolved in the hydrogenous gas that is diſengaged from the oil, that not an atom of it is to be afterwards found. This fact deſerves to be more particularly enquired into. There is alſo a little ſulphureous gas obtained by this decompoſition.

Fixed

Fixed oils feem not to be fufceptible of combination with pure metallic fubftances, excepting iron and copper, upon which they act in a fufficiently diftinct manner. But they combine with metallic oxides, and form with them thick concrete combinations, of a foapy appearance, as is obfervable in the preparation of unguents and plafters. Thefe preparations have not been yet chemically examined : only we know, that fome metallic oxides are reduced in the making up of plafters ; as, for inftance, oxide of copper in the Divine Plafter, and litharge, or oxide of lead, in the Ointment *de la mere.* In the affaying of metals, fixed oils are employed to reduce the metallic oxides. M. Berthollet has given an ingenious and fimple procefs for effecting inftantaneoufly a real combination between fixed oil and any metallic oxide, that is, for preparing a metallic foap. It confifts in pouring a metallic folution into a folution of common foap. The acid of the metallic folution combines with the fixed alkali of the foap ; and the metallic oxide is then precipitated in union with the oil, to which it communicates a colour. In this manner, foap of a beautiful green colour may be prepared with fulphate of copper; and with fulphate of iron, a clear deep brown foap. Thefe compounds might be very ufeful in painting.

Scheele has difcovered, that when oil of fweet almonds, olives, rapefeed, or lintfeed, is combined with oxide of lead, with the addition of a little water, there is a matter feparated from the oil, which fwims on the furface of the liquor, and to which he has given the name of *the mild principle.* On evaporating this fupernatant water, the principle diffolved in it caufes it to take the confiftency of fyrup ; when expofed to a ftrong heat, it takes fire : one part is volatilized, in diftillation, without burning : the coal which it leaves is light : it

does

does not cryftallize ; nor does it feem to be fufceptible
of fermentation. Nitric acid diftilled on this matter, four
times fucceffively, changes it into oxalic acid. This
mild principle of Scheele's appears to be a fort of mu-
cilage.

Fixed oils diffolve bitumens, particularly amber ; but
they muft be affifted by the action of heat, in order to
effect this folution. They form a fort of greafy varnifh,
which does not readily become dry.

Fat oils may be diftinguifhed into three genera :

To the *firft* clafs belong fuch pure fixed oils as are
fixed by cold, are flowly thickened, form foaps with
acids, and are kindled only by a mixture of fulphur and
nitre. Such are,

1. Oil of olives, obtained by bruifing that fruit between
two millftones, and preffing it in bags made of rufhes.
That which runs firft is called *virgin oil ;* that which is
obtained from mark fprinkled with water is not fo pure,
and depofites a lee ; that obtained from unripe olives, is
the *oleum omphacinum* of the ancients. Oil of olives
freezes at 10° degrees under Zero, in Reaumur's ther-
mometer, or $10\frac{1}{2}$ above that point in Fahrenheit's, and
will ftand about twelve years without becoming rancid.

2. Oil of fweet almonds, extracted without the appli-
cation of heat, becomes very foon rancid : it freezes at
6° under o in Reaumur's fcale, or $17\frac{1}{2}$ of Fahrenheit's.

3. Oil of rapefeed, obtained from the feed of a kind
of cabbage called *colfa.*

4. Oil of ben, extracted from the ben nut of Egypt
and Arabia. It is very acrid, and deftitute of fmell. It
freezes very eafily.

The fecond genus comprehends oils fubject to become
dry, which are very eafily rendered thick, are not
fixed by the action of cold, are kindled by the nitric acid,

and

and form with fulphuric acid a fort of refin. Such are,

1. Lintfeed oil, obtained by preffure from lintfeed. It is ufed for oily varnifhes, and in painting.

2. Oil of nuts, applied to the fame ufes.

3. Oil of carnations, or poppy feed; which, as has been fully proved by the Abbe Rozier, is not at all nar-cotic.

4. Oil of hempfeed, which is very drying.

Under the third genus, we comprehend concrete fixed oils, or *vegetable butters*; among which we may diftin-guifh the following:

1. Butter of cacao, extracted from the cacao nut.—There are four forts of cacao; the large and the fmall caracca, the berbice, and that of the Iflands. This but-ter is extracted from the nut by roafting, and fubfequent boiling in water; it is purified by melting it by a very moderate heat.

2. The cocoa nut affords a fimilar butter.

3. Vegetable wax is of the fame nature, only more folid. It is the production of China. It is there made into yellow, white, or green candles, the colour vary-ing with the manner in which the wax is extracted. The catkins of birch and poplar afford a fmall quantity of a fimilar wax.—That of Louifiana is more plenteous. M. Berthollet eafily whitens it with oxigenated muriatic acid.

Fixed oils are much ufed in the arts, and in medicine, and are applied to various purpofes. In the latter they are ufed as foftening, relaxing, calming, and laxative me-dicines. Some of them are even purgative; as, for in-ftance, the oil of Ricinus, which has been found to de-ftroy the tænia, or folitary worm, and caufe it to be e-vacuated.

vacuated. They enter into a great many compound medicines, such as balfams, unguents, and plafters.— Laftly, they are fometimes ufed as feafoning, or food, on account of their agreeable tafte, and the mucilage which they contain.

CHAP,

C H A P. X.

Of Volatile Oils.

VOLATILE or *essential* oils are distinguished from fixed oils by the following peculiar properties.—Their smell is strong and aromatic : They are so volatile, that they may be distilled by the heat of boiling water : Their taste is very acrid : They are much more combustible than the other class of oils.

Thefe oils are found to exist in almost all odorous plants. They are contained either in the whole plant, as in the angelica of Bohemia, or only in the root of the plant, as in starwort, the iris, white dittany, and kidney ; or in the stem, as in sandal, sassafras, and pine-wood ; or in the bark, as in cinnamon. Sometimes it is confined to the leaves, as in balm, peppermint, worm-wood, &c. In other plants, it is found in the calices of the flowers : Of this kind are the rose and lavender ; the petals of camomile and the orange-flower are filled with it. It is, at other times, fixed in the fruits, as in cubebs, pepper, and juniper-berries. Lastly, A number

of

of vegetables contain it in the feed ; such as nutmeg, a-
nife, fennel, and the many umbelliferous plants.

These oils differ from one another, 1. In their quantity,
which varies according to the state or age of the plant :
2. In confiftency ; fome are very fluid, fuch as thofe of
lavender, rue, &c.; fome congeal by cold, fuch as oil of
anife, and fennel ; others are always concrete, of which
kind are the oils of rofes, parfley, kidney-wort, and ftar-
wort : 3. In colour; fome are deftitute of colour; others,
fuch as oil of lavender, are of a pale yellow ; or a dark
yellow, as oil of cinnamon ; or blue, as oil of camomile ; or
fea-green, as oil of St John's-wort ; or green, as oil of par-
fley : 4. In gravity ; fome fwim on the furface of water,
moft of thofe, indeed, that are produced in temperate coun-
tries; others fink to the bottom of that fluid, as oil of faffa-
fras, of carraway feeds, and moft oils of this kind from hot
countries : this property, however, is not conftant with
refpect to climate, for the effential oils of pepper, nut-
megs, and mace, &c. are lighter than water : 5. In
tafte and fmell : the tafte of an effential oil is often very
different from that of the plant from which it was ex-
tracted ; pepper, for inftance, affords a mild oil, and oil
of wormwood is not bitter.

Volatile oils are extracted, 1. By preffure, from cedra,
bergamot, lemons, oranges, &c.; this is called *effence :*
2. By diftillation; the plant is put into the cucurbite of
a copper alembic, with water ; the water is boiled, and
the oil paffes together with the fluid, and gathers above
it in a receiver prepared for their reception.

Volatile oils are adulterated either by fixed oils, which is
detected by their ftaining paper ; or by oil of turpentine,
which may be difcovered by the ftrong fmell peculiar to
turpentine, which always remains after the effential oil
is

is evaporated ; or by alcohol and water, which, by rendering the mixture turbid, detects the alteration produced by this fubftance.

Volatile oils lofe their fmell by a moderate heat. As they are fo very volatile, fire does not decompofe them. When heated in clofe veffels, they give out a large proportion of hydrogenous gas. When heated in contact with air, they take fire fpeedily, and exhale a very thick fmoke, which is condenfed into a very fine, light, carbonaceous matter : They leave but very little coaly refidue after inflammation, being fo volatile, that the carbonaceous matter is formed in the part that afcends.

When expofed to the air, they become thick, and, in procefs of time, are converted into refins. They depofite needled cryftals, like thofe of fublimated camphire. Geoffroy the younger obferved thefe cryftals in the volatile oils of mother wort, marjoram, and turpentine. Their fmell, he informs us, is much the fame with that of camphire. *Acad.* 1721, *page* 163.

They combine with fome difficulty with lime and alkalis ; and form with thefe fubftances imperfect foaps, to which we give the name of *faponulæ :* Acids alter them ; the concentrated fulphuric acid changes them into bitumens ; when weak, it forms with them a fort of foap. The nitrous acid inflames them ; the muriatic acid reduces them to a faponaceous ftate ; the oxigenated muriatic acid thickens them.

They act not upon neutral falts.

They combine very eafily with fulphur, with which they form compounds that are called *balfams of fulphur,* in which the fulphur is fo divided that it cannot be extracted, but is feparated by heat in the form of fulphurated hydrogenous gas.

Mucilages

Mucilages and fugar render them foluble in water. They are ufed in medicine as cordials, ftimulants, antifpafmodics, &c. Externally applied, they are powerful antifeptics, and ftop the progrefs of caries in the bones.

<div style="text-align: right">C H A P.</div>

C H A P. XI.

Of the Camphorate Principle.

CAMPHOR is a white matter, concrete, cryftalline, and of a ftrong tafte and fmell ; in fome of its properties nearly allied to volatile oils, but widely diftinguifhed from them by others.

Chemifts have, from a great variety of obfervations, concluded camphor to be an immediate principle of vegetables, which, they think, exifts in all highly odorous plants that contain volatile oil. It has, in fact, been obtained from the roots of the cinnamon tree, zedoary, thyme, rofemary, fage, and many other labiated plants, either by diftillation or decoction, as has been obferved by Cartheufer and Neumann. But the quantity of the camphor thus obtained is very fmall, and it always retains a fmell of the plant from which it was extracted. This fingular fubftance appears to be combined with the volatile oils of thefe vegetables, as thofe oils have been obferved by Geoffroy to depofite needles of camphor. I have feen, in the poffeffion of M. Joffe, apothecary at Paris, true camphor extracted from the root of elecam-

pane.   Lorry thought camphor a very general principle in vegetables, and placed its aromatic flavour at the head of a clafs of very powerful odours, the effects of which on the animal œconomy well merit the attention of phyficians.

The camphor ufed in medicine is extracted from a fort of bay-tree that grows in China, Japan, and in the ifles of Borneo, Sumatra, Ceylon, &c.   The tree which produces it, often contains it in fuch abundance, that very large and pure tears of camphor may be obtained from it folely by fplitting the wood.   It is commonly, however, extracted by diftillation.   The roots, or other parts of the tree, are put into an iron alembic with water, covered over with a capital containing ropes of rice ftraw, and thus expofed to heat.   The camphor is fublimated in fmall greyifh grains; and thefe again unite into larger pieces.   This crude camphor is impure. The Dutch purify it by fublimating it in a fort of balloon, and adding an ounce of lime to the pound of crude camphor.

Camphor is much more volatile than the effential oils; for the gentleft heat is fufficient to fublimate it.   It cryftallizes in hexagonal plates, with a ftem in the middle.   When a ftrong heat is applied, it melts before volatilizing.   It does not appear to be decompofable by this means: however, when diftilled a number of times fucceffively, it affords a reddifh phlegm, evidently of an acid nature; and this fhews, that if the procefs were carried farther, its nature might at length be altered. The temperature of fummer is fufficient to volatilize camphor.   When expofed to the air, it is entirely diffipated and loft; when inclofed in clofe veffels, it is fublimated in hexagonal pyramids, or in polygon cryftals, which were in the year 1756 obferved and defcribed by Romieu.   It exhales a ftrong fmell, too ftrong indeed
for

for the nerves of fome people to bear. It takes fire
very eafily, burns with a good deal of fmoke, and leaves
no coaly refidue.

It is not foluble in water; it will, however, commu-
nicate its fmell to water: it burns on its furface. Romieu
has obferved, that fmall pieces of camphor, one third,
or one fourth of a line in diameter, when put into a
glafs of pure water, move round, till they are at length
diffolved in about the fpace of half an hour. He fufpects
this motion to be an effect of electricity; and obferves,
that it ceafes when the water is touched with any body
that can act the part of a conductor, fuch as iron wire;
and that, on the contrary, it ftill continues, though the
water be touched with an infulating body, fuch as glafs,
refin, fulphur, &c.

Earths, falino-terreous fubftances, and alkalis are in-
capable of acting on camphor. We muft obferve, how-
ever, that the power of cauftic alkalis on this fubftance
has not yet been brought to trial.

Acids, when concentrated, diffolve camphor. The
fulphuric acid diffolves it, with the help of heat: the fo-
lution is red. The nitric acid diffolves it flowly: this
folution is yellow. As it fwims over the acid in the
fame way as oils, it has been improperly called *oil of
camphor*. M. Kofegarten has difcovered, as has been
taken notice of in the VIIth Chapter, that the nitric acid,
when diftilled eight times fucceffively upon camphor,
changes into a cryftallizable acid, which he thinks to be
of a peculiar nature.

The muriatic acid gas diffolves camphor; fo likewife
do the fulphureous acid gas, and the fluoric acid gas.
When water is poured into thefe folutions, they become
turbid; the camphor is feparated in flakes, which fwim
on the furface of the liquor, and appear to have fuf-

fered no alteration.   Alkalis, the falino-terreous fub-
ftances, and metallic matters likewife precipitate thefe
folutions.

Neutral falts act not upon camphor.   We know not
in what manner fulphur and bitumens act upon this fub-
ftance ; but they are probably capable of combining
with it.

The fixed and the volatile oils diffolve camphor with
the help of heat.   Thefe folutions, when cooled, depo-
fite, by degrees, cryftals in a vegetative form, fimilar to
thofe that are formed in folutions of ammoniacal muri-
ate ; that is, confifting of a ftalk, with very fine fila-
ments extending from it horizontally.   Thefe filaments,
which in their difpofition refemble the beard of a fea-
ther, exhibit a very beautiful and regular appearance,
when viewed through a microfcope.   We owe this fine
fact to Romieu, *(Academy* 1756, *page* 448).   The folu-
tion of camphor in alcohol, which is much better known,
and much more in ufe than the preceding folution, was
obferved by the fame chemift to afford, by a particular
procefs, a fpecies of cryftallization fomewhat different.

Camphor is one of the moft potent remedies which
medicine employs.   It difpels inflammatory tumours in a
very fhort time.   It is ufed as an antifpafmodic and anti-
feptic medicine, in infectious diftempers, the malignant
fever, and all difeafes in general that are attended with
affections of the nerves, and putridity.   In France, it is
given only in dofes of a few grains : In England and
Germany, they go fo far as to give it in dofes of feveral
drachms a day.   It is alfo worthy of being mentioned,
that camphor alleviates burnings, and pains in the uri-
nary paffages, fo fpeedily, often, as might tempt the pa-
tient to think his relief the effect of enchantment.   It is
given, either triturated with the yolks of eggs, fugar,
                                                    and

and gums, or in the ftate of oil of camphor, and always in certain drinks prepared for the purpofe. Surgeons apply camphorated aquavitæ, of the compofition of which we fhall hereafter give an account, to external gangrenes; and the liquor often puts a ftop to their progrefs.

C 3 CHAP.

C H A P. XII.

Of the Spiritus Rector, or the Aromatic Principle of Plants.

BOERHAAVE gives the name of *spiritus rector* to that principle to which plants owe their smell: very little, however, is as yet known concerning the properties of this singular substance, which, from its influence on the animal œconomy, so strongly attracts our notice. We use the name *aroma*, instead of *spiritus rector*, deriving it from the well known term *aromatic*.

The aromatous principle of plants appears to be very volatile, very fugitive, and very subtle ; it is continually disengaged from plants, forming around them an odorous atmosphere, of a wider, or a narrower extent. Plants differ all from one another in the quantity, the strength, and the nature of their aromatous principle. Some are plenteously provided with this principle, and lose it only in part when dried, so that it would appear to be in some manner fixed in them : of this kind are in general all odorous woods, and all the dry and ligneous, odorate parts of vegetables. In others this principle is

fo

fo fugitive and volatile, that though they be ftrongly odo-
rous, they can fcarce be rendered permanently fo. Laft-·
ly, there are fome plants which poffefs the odorous
principle in fo low a degree, that they are faid to be
inodorous, and their *aroma* has been diftinguifhed as
herbaceous.

The flighteft degree of heat is fufficient to difengage
the aroma of plants. To obtain it, the plant muft be
diftilled in a *balneum-mariæ*, and its vapours received
into a cold capital, which may condenfe, and con-
duct them in a fluid ftate into the receiver. The pro-
duct is pure odoriferous water, and is known by the
name of effential or diftilled water.ᶠ This liquor is to
be confidered as a folution of the odorous principle in
water. That principle is more volatile than the water
in which it is diffolved. This aromatic water, when heat-
ed, lofes by degrees all its fmell, and becomes infipid.
It fuffers a fingular alteration when expofed to air ; it
then depofites very light flakes, of a mucilaginous ap-
pearance, and acquires a fmell of mouldinefs.

The principle of fmell combines with oily juices, and
even appears to conftitute one of the elementary princi-
ples of volatile oils; for, 1. Thefe oils are always im-
pregnated with it : 2. Thofe plants in which the prin-
ciple of fmell is confiderably fixed, afford invariably
more volatile oil than thofe of which the fmell is very
fugitive, many of which, as, for inftance, thofe of the lily
kind, often afford no volatile oil at all. The aromatic
water of this latter clafs of plants, fuch as the tuberofe
and the odoriferous lily, needs to be combined with
fixed oils, in order to prevent its efcape. The jafmine,
too, is of the fame character. The flowers of thefe
plants are put into a tin cucurbite with cotton moiftened
with oil of ben ; the flowers and the cotton are difpofed

in alternate layers; the cucurbite is then fhut, and ex-
pofed to a gentle heat: The aroma, difengaged from
the flowers, then combines with the oil, fo as to become
permanently fixed.   3. Plants that have no fmell, never
afford a fingle particle of volatile oil.   4. Vegetables,
from which aromatic water has been extracted by diftil-
lation on the balneum-mariæ, no longer afford any vo-
latile oil; at leaft, unlefs they ftill retain fome little
fmell; and even in that cafe they afford but a very fmall
quantity of oil.   5. Volatile oil that has loft its fmell,
readily regains it with all its properties, when diftilled on
a frefh plant of the fame fpecies with thofe from which
it was at firft extracted.

The action of faline matters on aromatic water has
not yet been examined.   M. Berthollet has difcovered,
that the oxigenated muriatic acid often deftroys the fmell
of vegetables, and of confequence alters their aroma.

The nature of this principle is not the fame in all
plants; it varies according to the genera of the plants
to which it belongs.   Macquer follows Boerhaave in
thinking, that it is generally a compound of an inflam-
mable fubftance with a faline matter; but obferves, that
it fometimes partakes more of a faline nature, and at o-
ther times approaches nearer in nature to oily matters.
The aroma of cruciform plants, he thinks to be faline;
and afcribes to it the characteriftics of being pungent
and penetrating, yet not affecting the nerves: That, a-
gain, which is infipid, or ftrong but not pungent, and
affects the nerves, fo as either to occafion, or to revive
from, fits owing to the particular ftate of the nervous fy-
ftem,—effects which aromatic and narcotic plants ufually
produce;—that, according to this celebrated chemift, has
more of an oily than of a faline nature. Several facts con-
cur to fupport this opinion.   The fraxinella diffufes an o-
                                                    dour

dour which forms an inflammable atmofphere around it; and whenever a burning body comes within this atmo- fphere, it takes fire; and the vapour then burns from the lower to the upper part of the ftem that fupports the flowers.

The aroma of the fraxinella feems therefore to be of an oily nature. Venel, a chemift at Montpelier, who ftudied under Rouelle, extracted an acid fpiritus rector from favoy (marum) by a gentle heat; and Roux, profeffor of chemiftry in the fchools of medicine, having examined the product, found that it did not redden vegetable colours, but fatu- rated alkalis. With refpect to the aroma of cruciform plants, chemifts are not yet agreed concerning its nature. Some think it acid; others call it alkaline. It appears from the experiments of Meffrs Deyeux and Baumé, that fulphur is found in combination with the odorate principle of antifcorbutic plants; and that it is that combuftible body, reduced to the ftate of elaftic fluidity by combination with hydrogene, which conftitutes the aroma of cruciform plants.

There are yet two important obfervations to be made concerning the aroma of plants. In the firft place, it is perhaps, as Macquer fufpected, a gas of a peculiar na- ture: its invifibility, its volatility, the manner in which it diffufes itfelf through the atmofphere, its power of expanfion, together with fome experiments by Dr In- genhoufz, on the noxious gas exhaled from flowers, ren- der this opinion highly probable.—What we want to determine this point, is a feries of experiments, which would indeed require to be performed with the utmoft care and accuracy, but would certainly accomplifh fome noble and ufeful difcoveries. Boyle has already opened a wide field of enquiry concerning fmells, their alterabi- lity and reciprocal combination: and that train of re- -fearch

fearch has been very fuccefsfully profecuted by Lorry.
This philofopher has obferved the alterations produced
on them by mixture with one another, by fermentation,
and by the action of fire, air, and different menftrua.—
We cannot, without making an improper digreffion, en-
ter here into a particular detail of his experiments ; but
we may mention his general divifion of fmells. Lorry
divides thefe bodies into five claffes, camphorate, æthe-
real, poifonous or narcotic, acid, and alkaline : All
fmells may, in his opinion, be referred to fome one of
thefe claffes. In explaining the grounds on which he e-
ftablifhes this divifion, with refpect to the manner in
which fmells affect the fenfe of fmelling, and the nerves
in general, Lorry informs us, that he propofes not to
examine their chemical nature : But it is probable, as he
himfelf thinks, that thofe of each clafs are nearly of the
fame nature in refpect to chemical properties, as well as
to the manner in which they affect the animal œconomy.

Our fecond obfervation, and with it we mean to con-
clude the chemical hiftory of the principle of fmell, is,
that, though the plants which have been called inodo-
rous, be thought to contain none of this principle ; yet
it is at prefent a well-known fact, that, by the gentleft
heat of a balneum-mariæ, there may be extracted from
them a water, of which the fmell, though very faint,
will however be fufficient to indicate from what plant it
was extracted.—I can affert this upon my own experi-
ence. I have often found thofe plants that are com-
monly reckoned the moft inodorous, fuch as fuccory,
plantain, borage, &c. to afford, by the balneum-mariæ, a
water that diffufes a fmell, by which the nature of the
plant from which it was extracted may be fufficiently
known. It is true, that thefe infipid aromatic waters are
very foon decompofed, and lofe, in a fhort time, that
													faint

faint fmell by which they are diftinguifhed : They are altered, and ferment, and pafs either into an acid or an alkaline ftate.

The perfumer's art, which preferves the odorous parts of vegetables, and fixes them in different fubftances, is founded on the chemical methods by which thofe parts are extracted from the vegetable. Moft of the proceffes of that art are entirely chemical.

Medicine, too, makes much ufe of diftilled or aromatic waters. They poffefs different virtues, according to the peculiar nature of each. Thofe employed for the purpofes of medicine are ufually diftilled by naked fire, with water, in the fame way as volatile oils. This manipulation anfwers very well for the aroma of fuch waters as are truly aromatic, but not fo well with 'thofe plants that are commonly called inodorous. Thefe ought to be diftilled in a balneum-mariæ ; and as this precaution is feldom taken, they have ufually an empyreumatic fmell acquired from the fire, even when not impregnated with the odorous principle of the plant.— If thefe waters owe all their virtue to the aroma which they contain, weak as that is, it is certain that the mode of preparing them deftroys all the properties which that principle can poffibly confer upon them.

To thefe obfervations we fhall only add, that the diftilled waters of plants prepared by the apothecary, are not that pure aroma which Boerhaave called *fpiritus rector*, but that principle, diluted in a large proportion of water, diftilled with the plants.

C H A P.

C H A P. XIII.

Of Resinous Inflammable Juices in general, and of Balsams in particular.

THE name, *Resins*, is given to certain dry, inflammable matters, which cannot be mixed with water, but are soluble in oils and alcohol, and run fluid from the trees in which they are produced. These matters are nothing but oils concreted by the desiccative action of the air. Various opinions are entertained concerning the difference between Balsams and Resins. Some give the name of Balsams to inflammable fluid substances; but there are also dry balsams: Others confine the name to the most odorous inflammable substances. Bucquet has thrown much new light on this matter, by confining the name of *balsams* to such of those combustible matters as are sweet-smelling, and can communicate their smell to water; and, especially, which contain odorate and concrete acid salts, that may be obtained from them by sublimation or decoction in water.

The principal species of balsams, are the three following:

1. Benzoin.

1. Benzoin. Of this there are two forts: the amygdaline benzoin, in white tears refembling almonds, united by a brown juice; and common benzoin, of a brown colour, not in tears: it exhales a very pleafing fmell, when melted, or pricked with a hot needle. The tree that affords it is unknown. This balfam comes to us from the kingdom of Siam, and the ifland of Sumatra. On account of its folidity, it affords but little effential oil. Boiling water extracts from it an acid falt in needles, which is ftrong fmelling, and cryftallizes by cooling. The falt is alfo obtained by fublimation. When obtained by this laft procefs, it is called *flowers of benzoin.* This operation is performed in two varnifhed earthen pots, placed one above the other, and made clofe with paper at the place of their junction. The fire muft be moderate, otherwife the falt becomes brown. The pafteboard cone which was formerly ufed for this purpofe fuffered a great deal of the concrete acid to efcape. We have given an account of the properties of this acid in a preceding chapter. Benzoin affords, in a retort, a very acid phlegm, a concrete brown falt of the fame nature, and brown thick oil: the refidual coal contains fixed alkali.

Benzoin is foluble in alcohol; and the tincture of this balfamic fubftance, precipitated by water, forms *lac virginale.* Salt of benzoin is ufed as a good incifive in pituitous diforders of the lungs and reins. The oil is difcuffive, and is externally applied to limbs affected with palfy, &c.

2. Balfam of Tolu, Peru, and Carthagena. This balfam is brought to Europe, either in cocoa nut-fhells, or in yellowifh tears, or in a fluid ftate: it flows from the toluifera, which Linnæus ranks in the decandria monogynia clafs. It may be extracted from the fhells, by

fteeping them in boiling water, which renders it fluid. It comes from a country in South America, fituated be-tween Carthagena and Nombre de Dios, called by the inhabitants of the iflands Tolu, and by the Spaniards Honduras. It affords, when analyfed, the fame pro-ducts as benzoin, and efpecially a concrete acid falt. It is made into fyrup; and adminiftered in difeafes of the lungs.

The acid of the balfam of Tolu has not been yet ex-amined: it is thought not to differ effentially from the benzoic acid.

3. Storax calamita is in tears, either red and clean, or brown and greafy. It fmells very ftrong; it runs from the oriental liquidambar, a plant that is but little known. Duhamel obferved a juice running from the *aliboufier*, that had nearly the fame fmell. Neumann analyfed the ftorax calamita, and obtained from it an effential oil, a concrete acid falt, and a thick oil. It ferves for nearly the fame purpofes as benzoin: it is chiefly ufed for per-fume. We formerly had it fent to us in reeds; but we now get it in loaves, or irregular maffes, of a reddifh brown colour, mixed with a few tears of a lighter colour, and a more pleafant fmell.

C H A P.

C H A P. XIV.

Of Refins.

RESINS differ from balfams, as having a lefs pleafing fmell; and, ftill more eminently, as containing no concrete acid falt. The following are the principal fpecies of refins.

1. Balfam of Mecca, Judæa, Egypt, Grand Cairo. It is liquid, white, bitter, and of an high lemon colour. It runs from a tree that is called *amyris opobalfamum,* ranked by Linnæus in the octandria monogynia, and difcovered in Arabia the Happy by M. Forfkahl. This liquid refin fometimes affords effential oil by diftillation. With fugar, and yolks of eggs, &c. it is ufed as a vulnerary.

2. Brown or yellow balfam of Copahu, which runs from the tree, called copaiba, and by Linnæus *copaifera,* and ranked by that botanift in the decandria monogynia. The common kind, both of this and of the balfam of Tolu, is, according to Cartheufer, a mixture of genuine balfam of Copahu with turpentine. It is ufed, as well as the preceding refin, as a remedy for ulcers of the lungs and bladder.

3. Chio

3. Chio turpentine runs from the turpentine tree that bears the piftachio nuts. It is of a white or yellow colour, inclining to blue. It affords on a balneum-mariæ a very fluid volatile oil : that which it affords by naked fire, is not fo fluid. The turpentine is, after this opera-tion, of a ftill yellower colour. When diftilled with wa-ter, it is white and filky, and is called boiled turpentine. This turpentine is not common, and is not applied to any ufe.

4. Venetian turpentine, or Milefian refin, is that moft commonly ufed in medicine. It is ufed either in its natural ftate, or combined with fixed alkali. This compofition has been called Starkey foap. We confider it as a *faponula.* To prepare it, the Paris Difpenfary directs to pour four ounces of volatile oil of turpentine on half a pound of nitre fixed by tartar and ftill hot ; to ftir the mixture with an ivory fpatula, and cover the veffel with a piece of paper ; adding oil, by degrees, till the whole form one white mafs. This procefs takes up feveral months ; and chemifts have therefore fought to find out fome more expeditious method of making up the medicine. Rouelle prepared, in the fpace of three hours, a pretty confiderable quantity of this foap, by triturating alkali with the oil dropped upon it, and add-ing a little water towards the end of the operation. M. Baumé directs to levigate upon porphyry one part of alkali of tartar, previoufly expofed to heat till it was brought near the point of fufion ; and to add to it, by degrees, two or three times its weight of volatile oil. When the mixture is brought to the confiftency of a foft opiate, put it into a glafs cucurbite covered with paper, and fet it afide in a damp place. In fifteen days time, the deliquefcent alkali forms a diftinct portion of liquor at the bottom of the veffel ; the foap occupies the middle ;

middle; and a portion of the oil, having affumed a red colour, fwims on the furface. M. Baumé thinks that the alkali unites only with that portion of the oil which is in a refinous ftate. M. le Gendre purfues this idea farther, and propofes to faturate a cold folution of the fixed alkali with concentrated oil of turpentine, or even with turpentine itfelf. This foap is in fome degree folid, and becomes gradually more fo : cryftals are formed in it, which have been confidered as a combination of the acid of the oil with vegetable fixed alkali. But, according to the academicians of Dijon, they are nothing but potafh faturated with carbonic acid, and cryftallized in that ftate. As it is no eafy matter to make up this foap, and it is befides very liable to alteration; Macquer thinks, that when a fubftance is wanted, poffeffing the properties of volatile oils, and thofe of foaps, in union, it were better on any occafion to incorporate a few drops of volatile oil with medicinal white foap, to ferve the prefent purpofe. Ammoniac, triturated with turpentine, forms a folid faponaccous compound, which diffolves very readily with water, and renders it milky and frothy.

5. The refin of the fir tree is called turpentine of Strafburgh. It is obtained by piercing the veficulæ of the bark of the fir tree, of which there are extenfive forefts on the hills of Switzerland.

6. Pitch is the juice of a fort of fir tree called *abies picea*. It is obtained, by incifion, from the bark of the tree. It is melted by a moderate fire ; preffed in bags of cloth ; and received into barrels : This is Burgundy pitch, or white pitch ; by mixture with lamp-black, it is converted into black pitch. When it is kept long in fufion with vinegar, it becomes dry and brown, and fo forms what is called *Colophony.* The more impure parts are

burnt in a furnace, with a chimney paffing into a fmall cabinet, terminating in a cone of cloth: the fmoke is condenfed in this cone, into a fine foot that is called lamp-black.

7. The Galipot is the refin of the pine which bears the foft apples. This tree is notched towards the bottom, and the refin runs out into troughs. When the refin ceafes to run out by the lower holes, they are continued up the tree. When it runs fluid, it is called Galipot; that which hardens upon the tree into yellowifh maffes, is called *Barras*. Thefe juices are liquefied in boilers; and, after being concentrated by heat, are filtrated through ftraw mats, and run into moulds in fand, or formed into loaves that are called *arcançon,* or *bray-fec*. When water is poured in, the matter becomes white, and forms *refin*, or *pitch-refin*. The inhabitants of Provence diftil galipot: they extract from it an oil which they call *huile de raze*. *Tar*, which is the empyreumatic oil of this fubftance, is prepared from the trunk and roots of the pine. A quantity of the wood is heaped together, covered with turf, and fet on fire. The turf hinders the oil that is difengaged by the heat from being volatilized; and it paffes into a fhallow tub through a channel, out of which it is removed, without farther preparation, to be fold as *tar*.

8. Tacamahaca, gum elemi, gum animæ are very little ufed. The tree that affords the firft is unknown. The *elemi* is produced by a fpecies of *amyris*. The oriental gum animæ, or copal, the origin of which is unknown, and the occidental gum animæ, or courbaril, which flows from the *hymenæa*, a tree that grows in South America, are ufed for varnifhes.

9. Maftic is in white, farinaceous tears, of a faint fmell: It flows from the turpentine tree, and the maftic tree;

it

It is ufed as an aftringent, and an aromatic; it enters into the compofition of drying varnifhes.

10. Sandarac is in white tears, more tranfparent than thofe of maftic. It is obtained from the juniper tree, in which it occupies a place between the bark and the wood. It is likewife called varnifh, as it enters into thofe preparations. It is ufed, in powder, to prevent ink from finking on paper, from which the external coating of fize has been fcraped off.

11. The refin of Guayacum, which is greenifh, is ufed as a remedy for the gout. It is obtained, by incifion, from the guayacum tree.

12. Labdanum, the refin of a fpecies of ciftus in Candia, is of a blackifh colour. The peafants gather it by ftriking the trees with ftaves, having a number of leather thongs fixed to the one end. They make it up into cylindrical pieces, which they call *ladanum in tortis.* It is adulterated by a copious addition of blackifh fand: It is ufed as an aftringent.

13. Dragon's blood is a red juice, extracted from the *dracæna draco,* and fome other trees of a fimilar nature. It comes to us in fmall flat cakes or round balls, or in little fpherical pieces, wrapped up in leaves, and knotted like a chaplet. It is ufed in medicine as an aftringent.

CHAP.

CHAP. XV.

Of Gum Refins.

GUM RESINS are mixed juices, confifting of refin and extractive matter, which has been taken for a gummy fubftance. They run by incifion, but never naturally, from trees or plants, in the form of white, yellow, or red emulfive fluids, which are fooner or later confolidated. Water, alcohol, wine, vinegar—none of all thefe liquors diffolves more than a part of gum refins. They differ in the proportions of the refin and the extract, and afford, by analyfis, many various refults. The following are the moft important fpecies:

1. Olibanum confifts of yellow, tranfparent tears, of a very ftrong and difagreeable fmell. It is not known from what tree it flows. It affords, by diftillation, a fmall portion of volatile oil, and an acid fpirit, leaving a pretty large refidual coal, produced from the extractive matter which it contains. It is ufed in fumigations as a refolvent medicine.

2. Galbanum is a fat juice, of a brown yellow colour, and a naufeous fmell. It runs, in Arabia, Syria, and at the Cape of Good Hope, from incifions in a ferulaceous

plant

plant called *Bubon Galbanum* by Linnæus. When diftilled by naked fire, it affords a blue effential oil, which afterwards becomes red, an acid fpirit, and a ponderous empyreumatic oil. It is an excellent difcuffive, and a powerful antifpafmodic.

3. Scammony is of a blackifh grey colour, a ftrong naufeous fmell, and a bitter and very acrid tafte. The fcammony of Aleppo is by far the pureft. That of Smyrna is ponderous, black, and mixed with extraneous bodies. It is extracted from the *convolvolus fcammonia* of Linnæus. The root of the plant, cut and fqueezed, affords a white juice, which, when dried, becomes black. The various fpecimens of fcammony contain various proportions of extract and refin; on which account, its effects as a medicine are far from uniform. It is given as a purgative, in dozes of from four to twelve grains. Mixed with a fweet extract, fuch as that of liquorice, it forms the common *diagredium.* It is likewife ufed for this purpofe with the juice of quinces. It is ufually given in a powder with fugar and fweet almonds.

4. Gum guttæ is yellow, reddifh, deftitute of fmell, and of a ftrong, acrid, and corrofive tafte. It comes from Siam, China, and the ifland of Ceylon. It is extracted from a large tree, very little known to us, and diftinguifhed in the countries where it grows by the name of *Coddam Pulli.* It contains a good deal of refin, which renders it ftrongly purgative, when adminiftered in dozes of four or fix grains. It fhould be very cautioufly adminiftered internally.

5. Euphorbium is in yellow tears, which are of a carious, or worm-eaten appearance, and have no fmell. It runs from incifions in the plant *euphorbium*, which grows in Ethiopia, Libya, and Mauritania. It contains a very acrid refin. It is fo ftrongly purgative, as to be ranked a-

mong

mong poifons. The only medical ufe for which it ferves, is, in external applications to caries.

6. Affa-fœtida is fometimes in yellowifh tears, but ofteneft in loaves, confifting of different pieces agglutinated together. It has a very fœtid fmell of garlic, and taftes bitter and naufeoufly difagreeable. It is extracted from the root of a fort of *ferula* that grows in the province of Chorazan in Perfia, and has been called by Linnæus *Affa fœtida*. The root of that plant is flefhy, and fucculent. It affords, by expreffion, a white juice, of an abominable fmell, ufed by the Indians as a feafoning, and called by them food for the Gods. It is ufed internally as a power-ful antifpafmodic, and externally as a difcuffive.

7. Aloes is a juice of a dark red, and fometimes even a brown colour, with confiderable bitternefs of tafte. There are three kinds of it : fuccotrine aloes, hypatic alocs, and caballine aloes. The firft is the pureft ; and it is only in purity the three forts differ. A. de Juffieu faw thefe feveral kinds of aloes prepared at Morviedro, in Spain, from the leaves of the common aloes. Deep incifions were made in the leaf ; the juice ran out by thefe : It was then decanted from above the fæcula, and thickened by expofure to the fun. The aloes prepared in this manner is put up in leather bags, and fold under the name of fuccotrine aloes. The juice fqueezed from the leaves, purified by reft, and then dried, forms hepatic aloes. Laftly, the leaves are again preffed ; and the juice now obtained from them, mixed with the lees remaining from the two former operations, forms caballine aloes. The firft of thefe different forts of aloes, contains much lefs refinous matter than either of the two latter, and is therefore much lefs purgative. It is ufed in medicine as a draftic purge, and is known to poffefs the property of
bringing

bringing on the menftrual flux with women, and the hæ-morrhoidal flux with men. It is recommended as an ex-cellent hydragogue.

8. Myrrh is in the form of reddifh tears, of a brilliant appearance, of a pretty ftrong but agreeable fmell, of a bitter tafte, and exhibiting in their fracture, when bro-ken, white lines of the form of a nail. Some of thefe tears are entirely gummy and infipid. Myrrh comes from Egypt, but chiefly from the ancient country of the Troglodytes, in Arabia. The plant that affords it is unknown to us. It contains much more extract than re-fin. It is ufed in medicine as a very good ftomachic, an antifpafmodic, and a cordial. Cartheufer advifes literary people, who have delicate ftomachs, to chew and fwallow it with their fpittle. It is ufed in furgery for cleanfing putrid ulcers, and ftopping the progrefs of caries, either in powder, or diluted in fpirit of wine.

9. Gum ammoniac fometimes appears in tears that are white internally, but externally yellow, and often in maf-fes much like thofe of benzoin. They are eafily diftin-guifhed, however, by their white colour and fœtid fmell. This gum refin which we get from Africa, is thought, on account of the feed mixed with it, to be extracted from an umbelliferous plant. This fubftance being folu-ble in water and fpirit of wine, as well as inflammable, is nearly of the fame character with thofe which Rouelle has named refinous extractive matters.

In medicine, gum ammoniac is ufed as a very good difcuffive, in cafes of obftinate obftruction. It is given in dozes of a few grains, either in pills or emulfions : it enters alfo into the compofition of many difcuffive and refolvent plafters.

10. Elaftic refin, or Caout-chouc, is a fubftance, con-cerning the nature of which it is hard to fay any thing.

Its containing combustible matter, a part of which is extracted in America for lights, is a characteristic in which it agrees with resinous substances: but its elasticity, softness, and insolubility in the menstrua which usually dissolve resins distinguish it as a substance of a different nature.

The tree which affords it grows in various parts in America. Incisions are made across its bark, which must always penetrate to the wood : a white juice, more or less fluid, flows from it, and is received into vessels, in order that it may be applied to the different purposes for which it is suitable : it is laid in layers on clay moulds ; and dried by exposure to the sun, or to fire. Various designs are then sketched upon them with the point of an iron instrument : they are then exposed to smoke ; and when sufficiently dried, the moulds are broken. In this way are formed the bottles, and other utensils of gum elastic, that come into Europe.

The vessels made of this matter are capable of holding water, and such other fluids as have no power of acting upon it. If it be cut into pieces, and the edges applied to each other soon after they are cut, the pieces unite again. I examined juice of caout-chouc, which was sent me from Madagascar. It was white as milk, and its smell insufferably foetid. It contained a concrete, white, spongy matter, in the middle of the bottle, of a similar form, and likewise elastic. When the liquor was heated, a white pellicle of genuine elastic resin was very soon formed on its surface. Alcohol, mixed with the juice, separated from it flakes of that resin.

When the caout-chouc, in a dry state, such as it is sent into Europe, is exposed to fire, it becomes soft, swells, exhales a foetid odour, and shrinks as it burns.

<div align="right">Elastic</div>

Elaftic refin is not foluble in water. We know not in what manner faline matters act upon this fubftance. Macquer, after trying to diffolve it in various menftrua, was convinced of what had been before afferted by Meffrs de la Condamine and Frefneau, *(Academy, year* 1751), that alcohol was incapable of acting upon it, but that oils diffolved it with the help of heat. However, as he wifhed to reduce it to a liquid ftate, fo that it might be made ufe of in that form, and might recover its properties by the evaporation of the folvent liquor, he was obliged to employ another menftruum than oils ; becaufe oils, however volatile, always altered the elaftic refin, and became fixed in it fo as to weaken its ftrength, and deftroy its elafticity. He, at length, diffolved this fubftance in highly rectified æther ; and it, being fo very fubject to evaporation, perfectly fuited his purpofe: *(Academy, year* 1768). And, though that liquor be indeed very dear, yet he thought it might be of fome confequence to make known to the public a method of making fome very ufeful inftruments, fuch as catheters, by putting, on a waxen mould, fucceffive layers of this folution, till they be of the required thicknefs. When the catheter is dry, let it be immerfed in boiling water, which, by melting the wax, feparates it from the mould. The foftnefs and elafticity of a catheter of this fubftance, render it the moft proper for perfons who find it neceffary to carry fuch an inftrument about with them.

Thefe are all the particulars of the hiftory of gum elaftic that were known to the world before the month of April 1781 ; at which time M. Berniard, diftinguifhed by the accuracy of his experiments, inferted in the *Journal de Phyfique* an excellent memoir on this fingu-

lar

lar fubftance. That chemift concludes from his experi-
ments, that elaftic refin is a peculiar fat oil, coloured by
a matter foluble in alcohol, and contaminated with the
foot of the fmoke to which each layer of the refin muft
be expofed, in order to dry it. Water produces no al-
teration upon it : alcohol, affifted by a boiling heat, dif-
colours it. Cauftic fixed alkali is incapable of acting upon
it. The concentrated fulphuric acid reduces it to a car-
bonaceous ftate, and is itfelf, at the fame time, tinged
with a black colour, and takes the fmell and the volati-
lity of the fulphureous acid. The common, or weak ni-
tric acid, acts on this refin in the fame way as on cork,
and gives it a yellow colour ; the nitric acid, ftrongly
concentrated, decompofes it very rapidly ; the muriatic
acid produces no fort of alteration upon it ; rectified
fulphuric æther did not diffolve it : This fact muft ap-
pear fingular, as the author obferves, to all thofe who
know the accuracy and veracity of Macquer. Nitric æther
did diffolve it. This folution is yellow, and affords, by
evaporation, a tranfparent fubftance, friable, and foluble
in alcohol ;—in a word, a genuine refin, formed, ac-
cording to this author, by the action of the nitric acid
on the elaftic caout-chouc. The volatile oils of laven-
der, afpic, and turpentine diffolved it with the help of
a gentle heat ; but they form clammy fluids, which
ftick to the hands, and cannot therefore be applied to
any ufeful purpofe. A folution of elaftic refin by oil
of afpic, when mixed with alcohol, depofited white flakes,
which were infoluble in hot water, but floated on the
furface of that fluid, and became, by cooling, white and
folid like wax ; in a word, they formed a genuine, fixed,
concrefcible oil. Oil of camphor diffolved elaftic refin
by fimple maceration. When the folution was evapor-
ated,

ãted, the camphor was volatilized; and there remained in the capfule an amber-coloured matter, of a firm confift-ency, but fcarce glney, and eafily foluble in alcohol. Fixed oils, when boiled upon elaftic refin, diffolve it: wax likewife diffolves it. This fubftance does not melt by a boiling heat; but when expofed to the action of fire in a filver fpoon, it is reduced into a thick black oil: •It then exhales white vapours; after which it remains fat and clammy, though expofed to the air for feveral months; nor does it ever again recover its drynefs and elafticity, which are fo neceffary to fit it for the purpofes to which it is applied. Laftly, M. Berniard concluded his experiments on this fubftance, by analyfing it by na-ked fire. From an ounce of gum elaftic he obtained a very little phlegm; an oil, which, though at firft clear and light, became afterwards thick and coloured; and ammo-niac, the quantity of which he does not fpecify: There remained a coal, fimilar to thofe of other refinous fub-ftances, which weighed 12 grains. This chemift afcribes the origin of the ammoniac to the foot which colours gum elaftic.

On this analyfis we may obferve, that it does not de-termine, in a very accurate manner, the nature of elaftic refin: for acids act not on this fubftance in the fame way as on fat oils; they act on thefe bodies with much more rapidity than on gum elaftic: neither do cauftic alkalis reduce it to a faponaceous ftate; nor does it melt, un-lefs a much ftronger heat be applied to it than what is fufficient to reduce the moft folid fixed oils to a ftate of fluidity: and, befides, no fixed oil ever becomes dry and elaftic like elaftic refin, &c. &c. In his fifth experi-ment, too, the author afferts this gum to confift of two diftinct fubftances, the nature of which he does not ex-plain;

plain ; and concludes with reprefenting it as a product
of human induftry.   From thefe reflections, and many
others which might be added, concerning thefe experi-
ments of M. Berniard's, which are in other refpects
very well performed, we are induced to think, that
much ftill remains to be done, as he himfelf acknow-
ledges, before we can be fully acquainted with the
properties of this fubftance, or decide with certainty
concerning its nature.

C H A P.

CHAP. XVI.

Of the Pure Fæcula of Vegetables.

THE juices of vegetables, when elaborated in their veffels, become thick, and are, by degrees, depofited on the furfaces of their fibres, where they contribute to their increafe and nourifhment, or are accumulated in a more or lefs folid form, in the different organs of which the vegetable confifts. After fpeaking of the fluid parts of thefe organic fubftances, we come next to examine the fubftance of which the contexture of their folids is formed.—We are, as yet, far from being fufficiently acquainted with the nature of all thofe folid matters which compofe the organs of plants. However, thofe particulars which are known to us, on this head, fhew that thofe organs, when treated by procefles which we are going to defcribe, are reducible to a dry, pulverulent, infipid, fubftance, either white, grey, or variegated with different colours, infoluble in cold water, and feemingly earthy, which is called *fæculum.*

To obtain this fubftance, the root, ftem, leaves, or feed of a plant, is pounded down to a pulp with a peftle.

When

When thefe parts are fucculent, there is no occafion for adding water to affift the procefs ; but this fluid is ufually employed to facilitate the feparation of the fibres, and to take up the attenuated, pulverulent parts. When reduced by this procefs to pulp, the vegetable fubftance is then fqueezed ; the juice, or water obtained from it by preffure, is either turbid, white, or coloured ; and it gradually depofites, by reft, a flaky matter, partly fibrous, and fometimes pulverulent, which is the true fæculum of the plant. Some parts of vegetables appear to confift entirely of this matter ; fuch as the feeds of gramineous and leguminous plants, tuberculous roots, &c. Thefe parts ufually afford the fineft fæculum, and the greateft quantity of that matter. As to the tender ftems and leaves, their texture, being more fibrous, never affords, when treated by this procefs, any thing but a coarfe, coloured, filamentous fubftance, which is known by the name of *coarfe fæculum.* If, after being thoroughly dried, thefe be reduced to powder, and the powder lixiviated, the water takes up a much finer fæculum, precifely of the fame nature with that of tuberculous roots and gramineous feeds. In the eye of the chemift, therefore, there is no other difference between thefe two kinds of fæcula, but that the firft is produced from a part which is lefs fibrous, not fo perfectly organized, and apparently formed of fmall cells, in which Nature has depofited a dry or farinaceous mucilage ; whereas the fecond, being wrought into a tiffue of fibres, needs to have its organization deftroyed, and to be attenuated by art.

Strictly fpeaking, all the folid parts of vegetables are capable of affording a fort of fæculum. But that which is prepared for the arts, for pharmacy, and for aliments, muft here be more immediately the object of our attention. The fæcula of briony, potatoe, caffava, fago, fa-
lop,

lop, ftarch, are thofe which deferve to be particularly taken notice of, as applied to thefe purpofes.

1. To prepare the fæcula of briony; take the frefh roots of the plant, ftrip off the bark, rafp the root to pieces, and then fubmit them to the prefs. The juice fqueezed out by the force of the prefs is white, and depofites a very fine fæculum. At the end of four and twenty hours, decant off the juice; dry the fæcula. As the juice muft have left in it a certain quantity of extract, it is very acrid, and purges violently. If wafhed, before being dried, it becomes finer and whiter, but lofes at the fame time its purgative powers. But this way of preparing the fæcula of briony affords only a very fmall quantity. Much more may be obtained by diluting in water the mafs which remains in the prefs, paffing that water through a hair-fieve, and fuffering it to ftand undifturbed, till it depofite the fæcula which it contains. When this is depofited, let the water be decanted off, and the fediment dried. This fæculum obtained by wafhing the lees, is not of a purgative nature like the former, as the water has carried off the extractive matter in which that virtue refided. M. Baumé has obferved, that the fæculum of briony, when well wafhed, bears an exact refemblance to ftarch, and that hair-powder might be made of it; by which means, the wheat made ufe of for that article would be fpared for other purpofes. The fæcula of the roots of calves-foot and cornflag are prepared in the fame way for medical ufe.

2. Potatoes, being fo plenteous, and affording in a crop fuch large increafe, form one of the moft ufeful articles of food. We can very eafily extract from them a great deal of very fine white fæculum, that becomes, by roafting, boiling in water, &c. a nourifhing article of food. This fæculum may be obtained by grating down
the

the potatoes on a fieve, and pouring plenty of water up-
on them. The fluid carries off the fineft and moft atte-
nuated portion of the fæcula, and, after ftanding for
fome time undifturbed, depofites it. Decant off the wa-
ter; dry the fæculum by a gentle heat: it is now in
the ftate of a very fine light white powder. For the
preparation of large quantities of this powder, mills, or
a fort of graters turning on cylinders, have been contriv-
ed, which appear to be very happily adapted to the pur-
pofe.

3. The Americans extract, from the root of a very
acrid plant called *manioc*, a very pleafant, nourifhing fæ-
culum, to which they give the name of Caffava. In
preparing it, they ftrip the root of its bark, grate it
down, and put it into a rufh-bag, of a conical figure,
and a very flight loofe texture, and hang the bag upon a
ftick, refting horizontally on two wooden forks. To the
lower end of this bag they fix a very heavy veffel, which,
by its weight, fqueezes out the juice, and, at the fame
time, receives it as it runs. The juice is a very acrid
and noxious poifon. When the fæcula are fufficiently
preffed, and all the juice drawn off, it is then dried by
expofure to fmoke, and paffed through a fieve; and now
it is in a proper ftate for being baked into caffava. It
is now fpread on an hot iron gridiron, and turned till it
be fo completely roafted, as to take, on both fides, a
reddifh yellow colour. In this ftate it is called Caffava
Bread. When expofed to heat in a bafon, and ftirred
from time to time, it takes, as it dries, a granulated form;
in which ftate it is called *Couac*. From the juice that
was fqueezed from the fæcula, there is, by degrees, a
very fine fweet-tafted fæculum precipitated, which is
called *Mouffache*, and ufed in paftry.

4. Sago

4. Sago is a dry fæculum, reduced to grains, and a little reddened by the action of fire, which we get from Java, and from the Molucca and Philippine islands.—It is extracted from a fort of palm-tree, called in the Moluccas *Landan.* The trunk of that tree inclofes a fweet marrow, which the inhabitants extract by fplitting the tree longitudinally. They then fcrape down this marrow, put it into a fort of cone or funnel made of the bark of a tree, place the cone upon an hair-fieve, and pour upon it a good deal of water.—The fluid conveys with it, through the holes of the fieve, the fineft and whiteft part of the marrow, leaving the fibrous part ftill upon the fieve.—The water impregnated with the attenuated part of the marrow is received into pots, in which the fæculum is foon depofited, and it becomes tranfparent.—The water is now decanted off, and the fediment paffed through fmall plates perforated with holes, which give it the granulated form by which fago is ufually diftinguifhed.—The reddifh colour of the furfaces of the grains is owing to the action of the fire by which they are dried.—Thefe grains become foft and tranfparent in boiling-water. With milk or broth they make a fort of foup, which is light, and far from difagreeable to the tafte, and is greatly recommended in phthifical cafes.

5. Salep, falop, falab, &c. is a fubftance which the inhabitants of the Eaft prepare from a fpecies of *orchis.* They felect the fineft bulbs of that plant, firft peel them, and then fteep them in cold, and boil them in hot water; next, after the water is well drained from them, they are ftrung in bunches, and dried in the air. M. Jean Moult gives another procefs for the prepartion of falep, by which it may be prepared from any fpecies of orchis.—

The roots muſt be rubbed, either dry or in water, with a bruſh, to remove the exterior pellicle, and then dried in an oven. They then become very hard and tranſpa-rent. But they may be very eaſily reduced to a powder; and this powder, diluted in hot water, forms a nouriſh-ing jelly, the virtues of which Geoffroy mentions with very laviſh praiſe, as highly efficacious againſt all diſeaſes occaſioned by an acidity of the lymph, more eſpecially againſt conſumptions and the bilious dyſentery.

C H A P.

C H A P.   XVII.

Of the Farina of Wheat, and of Starch.

STARCH, properly fo called, is a fæculum precifely of the fame nature with thofe of which we have already given an account: But as the farina of wheat, of which ftarch is a conftituent part, is one of the moft important matters that can engage the attention of the chemift, we fhall defcend to a much more particular account of this than we have given of any of the other fæcula.

What is called farina, is in general a dry, friable, infipid fubftance, capable of acquiring fapidity and digeftibility by the action of fire, and confifting of feveral matters which may be very eafily feparated from one another. This fubftance is difpofed by nature in the feeds of gramineous plants, efpecially in thofe of wheat, rye, barley, oats, rice, &c. Even leguminous plants appear to contain a compound of an analogous nature. There is, however, no other fubftance but the farina of wheat, which poffeffes all the fame properties : none but this farina poffeffes that juft proportion of the conftituent principles to which alone all its diftinguifhing

properties

properties can belong. Although the farina or flour of wheat has, from time immemorial, been ufed as a principal article of food, yet it has only within this fhort time begun to be chemically examined. Meffrs Beccari, an Italian phyfician, and Keffel Meyer in Germany, are the firft chemifts who attempted to - feparate the different matters of which farina confifts. Meffrs Rouelle, Spielman, Malouin, Parmentier, Poulletier de la Salle, and Macquer, have profecuted thefe refearches a great way farther than the above mentioned naturalifts. M. Parmentier efpecially has profecuted them with very uncommon zeal and induftry. His refearches into the nature of thefe alimentary fubftances, the principles of farina, the different kinds of fæcula, and concerning nutritious vegetables in general, are undeniably the moft compleat and accurate of any thing that we have of the kind.

Water is, of all agents, the moft ufeful, as it produces the leaft alteration on the various matters with which it becomes impregnated, or which it feparates, according to the laws of their folubility. Accordingly, it is by this fluid that the different matters of which the farina of wheat confifts are moft fuccefsfully obtained feparate from one another. In performing this true analyfis, a pafte is firft to be compofed of the farina with water; the pafte muft then be kneaded in an earthen veffel, with water pouring upon it from a cock; the fluid, as it falls upon the pafte, takes up from it a very fine white powder, by means of which it acquires the colour and confiftency of milk : let this procefs be continued till the water run off clear. The farina is now found to be naturally feparated into three diftinct fubftances—a grey elaftic matter that fticks to the hand, and on account of its properties has gained the name of the glutinous, or

vegeto-

vegeto-animal part,—a white powder which falls to the bottom of the water, and is the fæculum or ſtarch,—and a matter which remains diſſolved in the water, and ſeems to be a ſort of mucilaginous extract. Let us proceed to an examination of the properties of each of theſe three ſubſtances.

§ I. *Of the Glutinous Part of Wheat.*

THE glutinous part is a tenacious, ductile, elaſtic matter, of a whitiſh grey colour. It may be extended to twenty times its natural length ; and it then ſeems to conſiſt of fibres or filaments, diſpoſed beſide one another in the ſame direction in which it has been drawn out. When the power by which it was extended ceaſes to act, it then returns with elaſtic force to its primary form. By drawing it out in different directions, it may be rendered ſo fine as to reſemble, in the poliſh of its ſurface, the texture of the membranes of animals. In this ſtate, it adheres with conſiderable force to dry bodies, and forms a very tenacious glue, which was uſed by ſome people, for the purpoſe of re-uniting pieces of broken porcelain, long before chemiſts had found out the way of obtaining it in large quantities. M. Beccari obſerves, that in the beſt flour the proportion of the glutinous matter is from a fifth to a third part, or even more :— he remarks, too, that this proportion varies, according to the ſeaſon, and the nature of the corn.

The glutinous matter has an agreeable and ſomewhat mucous ſmell ; its taſte is inſipid ; it ſwells amazingly when expoſed to a ſtrength of heat ſufficient to dry it quickly. It dries very well by a moderate heat, or even in the dry air. It then becomes ſemitranſpa-

rent

rent and hard, like a ftrong glue, and, like that fub-
ftance, breaks with noife, and with a fmooth fracture.
If, when in this ftate, it be laid on a burning coal, or
held over the flame of a taper, it exhibits all the cha-
racteriftics of an animal matter; it crackles, fwells, be-
comes liquid, is agitated, and burns in the fame way as
a feather, or a piece of horn, exhaling a ftrong fœtid
fmell. When diftilled in a retort, it affords, like ani-
mal matters, water impregnated with ammoniac, ammo-
niacal carbonate, and an empyreumatic oil : the carbo-
naceous refidue is very difficult to incinerate, and is
found to contain no fixed alkali.

The gluten, when expofed frefh to a moift and hot
air, is altered, and actually putrefied in the fame manner
as animal matters. If it ftill retain a little ftarch, then
the ftarch, paffing into the ftate of acid fermentation, re-
tards and modifies the putrid fermentation of the gluten,
and reduces it to a ftate in which it is much like cheefe.
In this way Rouelle, the younger, prepared, from this
gluten, a fpecies of cheefe, in tafte and fmell much the
fame with Dutch cheefe, and that of Gruyere.

Water does not at all diffolve this glutinous matter.
When boiled in that fluid, it becomes folid, and lofes its
tenacity and elafticity, but neither acquires a tafte, nor
becomes foluble in the faliva. We may however ob-
ferve, that to the water which was ufed in making the
pafte the gluten owes its elafticity and folidity. In the
farina, this vegeto-animal matter, which is thus fufcep-
tible of a folid elaftic form, was in an incoherent and
pulverulent ftate; but when the water is poured upon
the farina, and mixed with it, thofe particles which are
of a glutinous nature abforb the fluid, and are by its
means fo clofely united as to form, in a fhort time, that
fort of elaftic folid which is known by the name of glu-
ten.

ten. Water, therefore, contributes greatly to the form-
ation of this fubftance, which is perhaps to be confider-
ed as a peculiar compound faturated with water, and,
for that reafon, not capable of abforbing any more. So
true is this, that if it be deprived of its water by defic-
cation, it lofes entirely its elaftic and adhefive powers.

Moft faline fubftances act either with more or lefs
force on this gluten. Potafh and foda, in a cauftic and
liquid ftate, diffolve it with the help of a boiling heat.
The folution is turbid, and, on the addition of acids, de-
pofites gluten, which, however, is deftitute of elafticity.

The mineral acids diffolve this gluten. The nitric
acid diffolves it with great activity; and M. Berthollet
has obferved, that this gluten, as well as animal fub-
ftances, gives out azotic gas, when expofed to the action
of the nitric acid. After the emiffion of this elaftic
fluid, the folution affords a great deal of nitrous gas, and
takes a yellow colour. By evaporation it affords oxalic
acid in cryftals. The fulphuric and the muriatic acids
form with this fubftance brown or violet folutions. A
fort of oily matter is feparated from thefe folutions : the
gluten exifts in them, in a real ftate of decompofition,
M. Poulletier, who has made many experiments on this
matter, has difcovered, that, from thefe combinations,
diffolved in water or alcohol, and evaporated in the
open air, there may be ammoniacal falts obtained.

From what we have related concerning this fubftance
it appears, that it is entirely different from all of thofe
which we have before taken notice of, as exifting in ve-
getables; and that in many of its diftinguifhing pro-
perties, it bears a great refemblance to the fibrous part
of blood. It is to this gluten the farina of wheat owes
its property of forming a clammy pafte with water, and
its readinefs to rife with leaven. It appears either not to

exift,

exift, or to exift only in a very fmall proportion in the farina of other vegetable fubftances, fuch as rye, barley, buckwheat, rice, &c. all of which form folid, opaque paftes, fcarcely ductile, and brittle, and which can fcarce be raifed when expofed to the fame temperature by which pafte of the farina of wheat is raifed. No other fubftance but flour of wheat, therefore, is poffeffed of all the qualities neceffary for making good bread.

M. Berthollet is of opinion, that this glutinous fubftance, like animal matters, contains phofphoric falts, which are the occafion of its coal being fo difficult to incinerate. Rouelle the younger has difcovered a glutinous fubftance, refembling that of the farina of wheat, in the green fæcula of plants, which afford, by analyfis, ammoniacal carbonate and empyreumatic oil, like the vegeto-animal matter of which we have been fpeaking.

§ II.   *Of the Starch of Wheat.*

STARCH, the amylaceous fæculum, is the moft copious part of the farina. This is the fubftance which is carried off, and afterwards precipitated from the water with which the pafte is wafhed in order to obtain the pure gluten. This fubftance is very fine, feels foft, and has no perceptible tafte. Its colour, when it is extracted by the procefs above defcribed, is a dirty grey white; but the manufacturers of ftarch render it exceedingly white, by fteeping it in an acid water which they call *four water*. It appears, from the experiments of M. Poulletier, that the fermentation which takes place in that fluid whitens and purifies the ftarch, by attenuating and even deftroying the extractive mucous fubftance which is precipitated with it in the firft wafhing. Starch, chemically confidered, is a mucilage of a peculiar nature.

nature. This mucilage, which, by fome chemifts, has been miftaken for an earth, is very different from the gluten. It does not, like the gluten, diffufe an empyreumatic fmell, when it burns. When diftilled by naked fire, it affords an acid phlegm, of a brown colour, and, towards the conclufion of the procefs, a very thick empyreumatic oil. The coaly refidue is eafily enough incinerated; and its afhes are found to contain fixed alkali.

Starch is not foluble in cold water; but when boiled in water, it forms with the fluid a glue, or rather what in French is denominated by the peculiar name of *empois*. This compound, when expofed to damp air, lofes by degrees its confiftency, ferments, becomes four, and is covered over with mouldinefs.

The nitric acid affords, with this fæculum, oxalic acid, perfectly the fame with that of which we have fpoken in the foregoing chapter.

As ftarch forms the greateft part of flour, there can be no doubt of its being the principal alimentary fubftance contained both in flour and in bread.

§ III. *Of the Extractive Mucilaginous Part of the Farina.*

BY evaporating the clear water that had been ufed in wafhing the pafte, and had depofited the ftarch, M. Poulletier obtained a vifcous, adhefive matter, of a brown yellow colour, the tafte of which was faintly faccharine. This fubftance, to which he gave the name of *mucofo-faccharine*, difplayed, in combuftion and diftillation, all the fame phænomena with fugar. By it, the acid fermentation is produced in the water which fwims over ftarch; for, as Macquer has obferved, ftarch is not at all foluble in

cold

cold water. The mucofo-faccharine matter exifts in the farina of wheat only in very a fmall proportion. It may, poffibly, be more copious in the farina of fome other vegetable fubftances.

However fmall the proportion of this fubftance in the farina of wheat, yet there can be no doubt of its acting a peculiar part in the fermentation which takes place in pafte, and caufes it to rife. The nature of this motion, fo neceffary to render bread wholefome, is ftill but very little known. It would appear to be nothing more but the beginning of a putrid fermentation in the gluten, an acid fermentation in the ftarch, and perhaps a fpiritous fermentation in the mucofo-faccharine matter. Thefe three incipient fermentations, which mutually oppofe each other, are perhaps what produces the compound, fo much lighter than dough, which, by baking, and a proper expofure to heat, forms bread. One thing certain is, that, in bread, all the three fubftances which we have here examined, are found exifting together, but fo much altered, that they can no longer be extracted feparately. Even the action of heat alone, without the motion of fermentation, is fufficient to change the nature of thefe three fubftances, and combine them in fuch a manner, that even from bread, unleavened, or baked without being raifed, Malouin and M. Poulletier tell us, the gluten can no longer be obtained.

From thefe particulars we underftand, how that all flour but that of wheat, and, ftill more, the leguminous or farinaceous feeds, fuch as beans, peas, chefnuts, &c. is far from poffeffing the qualities requifite for making good bread.

C H A P.

C H A P. XVIII.

*Of Vegetable Colouring Matters, and their Applica-
tion to the Art of Dyeing.*

VEGETABLES contain colouring matters through
all their organs. Thefe matters are extremely
various. It often happens, that a vegetable matter which
has, of itfelf, no apparent colour, affumes a very diftinct
one, when expofed to the action of certain menftrua. The
art of dyeing, all the proceffes of which are entirely
chemical, is founded on the knowledge of the folubility
of thefe colouring parts of vegetables, in various men-
ftrua,—of the way of applying them, fo as to communicate
colour to other fubftances,—and of rendering them perma-
nent and tenacious on thofe fubftances. In examining
the properties of each of the colouring matters, we will
have occafion to give fome account of the principles of
this important art, on which Meffrs Hellôt, Macquer,
le Pileur d' Apligny, Hecquet d' Orval, and the Abbé
Mazéas have already publifhed excellent works.

It appears that the colouring matter of vegetables, pro-
perly fo called, is ftill unknown. Roulle was of opinion,
that the green part, fo copious in the vegetable kingdom,

was

was fimilar in nature to the gluten of the farina. But it is certain, that this matter exhibits different chemical cha-racteriftics, according to the diverfity of the bafes with which it is united. It is, therefore, rather the bafe, than the colouring part itfelf, of which we fpeak, when we fay, fuch a colour is extractive, and fuch another colour refinous, &c. The fubftance which really colours thofe parts of vegetables that are employed in the arts, is, no doubt, a very fubtle body, perhaps not lefs fo than the principle of fmells. There is even fome reafon to think, that it confifts folely in a certain modification of the folid and liquid parts of vegetables.

It may be proper to recollect here, that the colouring of vegetables depends, in a great meafure, on the contact of light. But, in what manner the contact of light con-tributes to the production of colours, is a problem, of which the refearches of the natural philofopher have, as yet, afforded no folution. Whatever that may be, as it is im-poffible to feparate the colouring matter entirely from the vegetable bafe to which it is united, it is generally agreed to confider thefe two fubftances together as the colouring matter of plants.

Of all chemifts, Macquer has beft diftinguifhed the na-ture of the different colouring matters of vegetables, con-fidered with refpect to the art of dyeing: And his theory concerning the application and the fixation of colours on other fubftances in dyeing, is beyond a doubt the moft fatisfactory. As I intend here to connect that theory of dyeing, with the hiftory of the chemical properties of the colouring parts of vegetables, I fhall begin with the con-fideration of thofe properties.

1. A great many vegetable colouring matters, which are either extractive or faponaceous, diffolve very readily in water. Baftard rocket, madder, logwood, redwood, and

Brafil

Brafil wood afford yellow or red colours of this fort. It is eafy to fee, that matters dyed with thefe colours, muft lofe their tincture in water: on this account, there is employed, to render thefe colours permanent, fome additional matter capable of fixing and decompofing them; fuch as crude tartar, alum, and other falts. Thefe falts are called *corrofives*. A folitary acid might produce the fame effect; but would alter the colouring matter. The fuperfluous portion of the acid of the alum combines with the alkali of the faponaceous colouring extract, and occafions the precipitation of the refinous part of that extract, which is then infoluble in water, upon the fubftance intended to be dyed. This colouring part, however, which is rendered infoluble by the alum, or the corrofive, is of two kinds. The firft is very folid, and refifts the action of air, of foaps, and of all the liquors ufed by dyers as proofs. The other is liable to be altered by air, and ftill more by the proof liquors: it is called a falfe dye. In order to afcertain the nature of thefe colours, and the durability of dyes in general, M. Berthollet has propofed the ufe of the oxigenated muriatic acid. That acid effects, in a very fhort time, by means of its excefs of oxigene, what the vital air of the atmofphere takes up a longer courfe of time to accomplifh: And, by obferving what quantity of this acid is neceffary to difcolour and entirely whiten any dyed ftuff, as well as the time which it takes to produce the effect, a judgment may be formed of the folidity and the durability of the colours thus fubmitted to examination.

It is obfervable that wool takes a dye better than any other fubftance; and, next after wool, filk, cotton, and flax, in the order in which they are here mentioned, receive [a dye, each of them with more difficulty than the preceding one, and lofe it fooner.

Thofe

Thofe authors who have written upon the art of dyeing, have maintained different opinions concerning the way in which colouring matters act on the fubftances expofed to their operation. Many have fuppofed, that in proportion as the pores of the fubftance to be dyed are more or fewer, greater or fmaller, the colouring matter is more or lefs completely applied to it; and that the reafon why wool takes a colour better than filk or thread, is becaufe its pores are more open and more numerous than thofe of either of thefe fubftances. But Macquer thinks the true caufe which renders the application to any fubftance more or lefs eafy, is, the relation between the colouring matter and the body to be dyed being nearer or more remote. Dyeing, in his opinion, is actually nothing but painting, which fucceeds and lafts only by virtue of an intimate affinity between the colouring matter and the dyed fubftance. That celebrated chemift adopted this opinion in confequence of the numerous experiments which he made in the art of dyeing; which is indeed highly indebted to his difcoveries.

2. There is another clafs of colouring matters, which feem to confift of refin and faponaceous extract. Macquer calls them *refino-terreous* matters. When thefe matters are boiled in water, the refinous fubftance which they contain is melted, and diffufed through the fluid, by means of the action of the heat, and the folution of the faponaceous part: but it is precipitated as the bath or decoction cools. When, therefore, wool, or any other matter, is immerfed in a decoction of mixed colouring matter of this kind, the refin is feparated by cooling; and, without requiring any farther procefs, fixes on the fubftance thus expofed to it. Not being foluble in water, it forms a permanent dye. Colouring matters of this kind are obtained from almoft all aftringent vegetables, fuch as the

                                                                huſks

hufks of nuts, the roots of the walnut tree, or of dock, fumach, bark of alder, fandal wood, &c. Thefe colours are all yellow, and are called by the dyers' root-colours. They are generally ufed to form a good ground, on which colours of a higher luftre may be laid. We may further remark, that the colouring matters, for the application of which no particular preparation, either of themfelves, or of the bodies to which they are to be applied is requifite, afford the fimpleft tincture, and are the eafieft applied to ufe.

3. The colouring principle of various other fubftances exifts in a matter that is purely refinous, and infoluble in water. Several of thefe matters are not foluble even in alcohol; but, in alkalis, they are all diffolved, and reduced into a fort of faponaceous ftate, in which they are foluble in water.—The following are the principal colours of this fort ufed in dyeing.

A. The annatto, a kind of fæculum obtained by maceration from the feeds of the *urucu* putrefied in water. This fæculum is depofited during the putrefaction of the fubftances. It is at firft red, but, in courfe of time, becomes of a brick-duft colour. Stuffs intended to be dyed with this matter, are immerfed into a lixivium of this pafte, with the *cendres gravelées*, which we are fhortly to defcribe, mixed together in water. Without the affiftance of any corrofive, there is depofited on the fubftances immerfed into this lixivium a golden yellow, or orange colour, of confiderable beauty.

B. The flower of Carthamus or baftard faffron affords, by the fame procefs, a very beautiful red colour. This flower has two different colouring parts: the one purely extractive, and foluble in water; the other refinous.—To obtain the latter, the foluble part of the carthamus muft firft be carefully wafhed away: What remains

mains after the wafhing muft be mixed with the *cendres gravelées*, or foda; this mixture is then to be formed in-to a lixivium, and employed in dyeing. But as the al-kali alters the colouring matter, and tarnifhes the colour, the dyed fubftance is fteeped in water, acidified by lemon juice. This acid, feizing the alkali, the colouring matter is left at liberty; in confequence of which it regains its original properties, and becomes red. By a fimilar procefs, there is a coloured fæculum obtained from car-thamus, which, mixed with Briançon-chalk in powder, compofes the *rouge* made ufe of by the ladies.

C. Archil is a pafte prepared from mofs and lichen, macerated in urine, with lime. The lime difengages the volatile alkali; and that caufes the red colour to appear. Archil diluted in water communicates a dye without any other preparation with alkalis. It gives a violet co-lour; but this is a falfe dye, which is altered in the air, and rendered yellow by the action of acids.

D. Indigo, the colour of which is a deep violet blue, feemingly of a cupreous nature, is a fæculum prepared at St Domingo, and in all the Antilles, &c. by macerat-ing the ftalk of the *Antillo* or indigo plant in ftone troughs, with water. The water becomes blue; and, after it has been for fome time violently ftirred, the fæ-culum is precipitated. The indigo feparated from the water is put into cloths to drain. It is then dried in fmall wooden boxes, and, when dry, broken into pieces. When it floats on water, and burns entirely away on a red-hot fhovel, it is efteemed good. The colouring part of it is extracted by alkalis, and applied to the matters intended to be dyed, without any farther preparation.— It cannot be brightened by acids, as thefe would alter the colour.

4. There

4. There are certain colouring matters foluble in oils. Alkanet, or the red root of a fort of buglofs, communicates its colour to oil. Alcohol likewife diffolves feveral colouring matters: Green fæcula diffolve in it as well as in oil. It may be eafily underftood, that thefe colours cannot be ufed in dyeing; becaufe the liquids neceffary to extract them cannot be employed.

Such are the principal facts at prefent known concerning the nature of vegetable colours. From thefe it appears, that any of the immediate principles of vegetables may become the bafe of their colouring parts; as we find them to be faponaceous, refinous, and extractive.— Some of them even appear to be of the fame nature with fixed oils, and are not foluble either in water or in alcohol, but diffolve readily enough in alkali. Laftly, There are, according to Rouelle, fome of thefe colouring parts of the fame nature with the glutinous part of vegetables.

There is every reafon to think, that future enquiries may difcover various other properties in thefe matters which are fo copious in vegetables, and thus carry to ftill higher perfection the art of dyeing, one of thofe arts to which chemiftry is capable of rendering the moft effential fervices.

CHAP. XIX.

Of the Analyſis of Plants by Naked Fire.

AFTER examining all the matters which can be ob-
tained from vegetables, by ſuch ſimple means as
produce no alteration in their nature, and conſidering
theſe matters as the immediate principles of thoſe or-
ganized bodies; it will next be proper to conſider what
alterations they are liable to ſuffer from fire.

The ancient chemiſts were acquainted with no other
method of analyſing vegetables but this; and all their
enquiries into the nature of theſe ſubſtances were direct-
ed only to diſcover, how much ſpirit, oil, and volatile ſalt
they afforded by diſtillation in the retort. At preſent,
we give but little credit to the reſults of this proceſs.——
We know, that all plants give nearly the ſame products;
and the diſtillation of a great many different vegetables,
by chemiſts in other reſpects very ſkilful and highly re-
ſpectable, has only ſerved to undeceive us with reſpect to
this analyſis. How, indeed, can it be thought, that the
action of fire, which is exerted on all the different prin-
ciples contained in a vegetable, extract, mucilage, oil, re-
ſin, ſaline matter, gluten, &c. and which decompoſes
each

each of them in a peculiar manner, can afford any certain information concerning the nature and the quantity of thofe principles? efpecially when we obferve, that the products of thefe different decompofitions form, by mutual combination, new bodies, which did not exift in the vegetable under examination. The analyfis of vegetables in the retort is therefore falfe and complicated.

However, as in a chemical examination of any fubftance, we fhould not refufe the ufe of any means which art fupplies for the difcovery of its nature, we may have recourfe to this analyfis, and obferve its effects, provided we be fufficiently on our guard againft giving too much credit to its refults: Nay, it fometimes happens, that when, in a feries of experiments on any vegetable fubftance, in order to difcover its chemical properties, we compare the effects of aqueous, fpiritous, and oily menftrua on that fubftance, with the alterations which it fuffers from fire; thefe alterations accord with the action of the folvents, and fhew, by the products of the diftillation, what matter is contained in a larger or a fmaller quantity in the vegetable, the nature of its falt, &c. But, that we may be able to make fuch important deductions from an analyfis by naked fire, it is requifite, 1. That we be well acquainted with the manner in which fire acts on each of the immediate or proximate principles of vegetables, the extract, the mucilage, the faline matter, the oily juices, fluid or dry, &c. 2. That we compare the products of the diftillation of the whole vegetable with thofe which its proximate principles generally afford, when treated in the fame manner. 3. That we, at the fame time, analyfe the vegetable by menftrua, in order that we may diftinguifh its proximate principles, and draw fome ufeful inferences concerning the alterations which it fuffers from fire.

.The

The procefs neceffary for the diftillation of vegetables by naked fire, is very eafy and very fimple.—Put into a glafs or earthen retort a certain quantity of the dry vegetable :—care muft be taken, however, to fill the veffel only half, or not more than two-thirds full. Place the retort in a reverberatory furnace ; to its neck adapt a balloon of a proper fize. There ufed to be formerly recommended for this purpofe, a balloon perforated with a fmall hole, to afford a paffage for the air which was faid to be difengaged, in a fmaller or a larger quantity, from the vegetables, and was likely, if confined, to break the veffels. At prefent we know, that the aeriform fluid which efcapes from thefe bodies, when fubjected to diftillation, is never air, but rather carbonic acid and hydrogenous gas, with carbonaceous matter diffolved in them. But as thefe elaftic fluids are products of the vegetable decompofed by the action of fire, as well as the phlegm, the oils, and the volatile falts ; it is no lefs neceffary to collect them than thefe latter fubftances. For this purpofe, there may be employed a perforated receiver, joined to a curved fyphon, entering by one end into a bell-glafs filled with water, or rather with mercury. By this means, the liquid products are collected into the receiver, and the aeriform products into glafs veffels, placed on the fhelf of a pneumato-chemical apparatus. When the fubftance diftilled is fuch as can afford any concrete falt, there is put between the retort and the receiver an adapter, or long glafs veffel, in the form of a fpindle, on the fides of which the falt fixes as it is fublimated. In this fort of diftillation, the fire fhould be gradually and cautiously applied, that the products may be obtained in the order of their volatility, without being confounded together. The procefs begins with placing a few coals under the retort, and the fire is by degrees

                                                            increafed

increased till the veffel become red-hot, and the paffing of the products into the receiver appear to have ceafed. The retort is now fuffered to cool, the luting removed from the apparatus, and the products examined.

Although the products obtained by the diftillation of vegetables are never to be entirely depended upon, yet fo much do they differ from one another, that they well deferve to be carefully diftinguifhed.

The firft product obtained is an aqueous liquor, impregnated with fome odorous and faline principles. This phlegm affumes by degrees more colour, and more faline properties. After it, comes a coloured oil, the colour of which becomes deeper, as the procefs advances. This oil is fometimes light and fluid, at other times weighty and liable to become folid. It conftantly exhales a ftrong empyreumatic fmell. At the fame time with it, there is a fmaller or a greater quantity of elaftic fluids difengaged; which are either carbonic acid, or hydrogenous gas, or, which is moft frequently the cafe, a mixture of thefe two fubftances. At the fame inftant, too, ammoniacal carbonate is fublimated, if the nature of the vegetable be fuch as to afford it. After all thefe matters have paffed, the vegetable is found reduced to a carbonaceous ftate. Let us now return to a more particular examination of each of thefe products, and attempt to diftinguifh what is their nature, and to what fubftances they owe their formation.

The phlegm is owing to the water which enters into the compofition of the vegetable, and in part to the water of its vegetation; and this efpecially, when the body analyfed is not entirely dry: and accordingly, the quantity of this phlegm is greater or lefs, in proportion as the vegetable has been more or lefs thoroughly dried before it was fubmitted to diftillation. This phlegm is coloured

of

of a lighter or a deeper red by the ſmall portion of oily
matter which it carries off with it, and which is reduced
to a ſaponaceous ſtate by the ſalt that is uſually dif-
ſolved in it.   The ſaline matter in union with it,
is moſt commonly acid ; on which account this phlegm
uſually reddens ſyrup of violets, and produces an effer-
veſcence with alkaline carbonates.   This acid belongs
to the mucilages and oils.   The phlegm is ſometimes of
an alkaline nature, as in the diſtillation of nitrous and
cruciform plants, and of emulſive and farinaceous ſeeds.
It is frequently ammoniacal ; becauſe the ammoniac
which follows immediately after the acid, combines with
it.   Of this fact full evidence may be obtained, by
throwing a little fixed alkali or quicklime into the
phlegm: When it is ammoniacal, there is a lively ſmell
diffuſed from the ammoniac.

    The oils obtained from vegetables by diſtillation in a
retort, are all ſtrong-ſmelling and high-coloured, and ex-
hibit all of them nearly the ſame properties.   Thoſe
parts of vegetables which contain a great quantity of
theſe inflammable fluids, ſuch as emulſive ſeeds, afford,
when analyſed, a good deal of oil.   The odorous plants
afford an oil which, in the beginning of the proceſs of
diſtillation, retains ſomewhat of their ſmell, but ſoon aſ-
ſumes the common characteriſtics of all theſe oils, that is
to ſay, the colour, gravity, and empyreumatic ſmell by
which they are diſtinguiſhed.   All of theſe fluids are
highly inflammable ; the nitrous acid cauſes them to
flame : they are ſoluble in alcohol, and bear, all of them,
ſome reſemblance to the vegetable from which they
were obtained.   By rectification, they may all be ren-
dered very fluid, very light, colourleſs, ſoluble in alco-
hol ; in a word, they may thus be reduced to the ſtate
of æthereal or volatile oils.

                                                With

With respect to the volatile salt, which is nothing but ammoniacal carbonate, it is obtained only from a few vegetables; but we must not imagine, as has been advanced by some chemists, that it is to be obtained only from cruciform plants. All plants, in general, containing a certain quantity of glutinous or vegeto-animal matter, afford more or less ammoniac; because, as has been fully proved by M. Berthollet, that principle of vegetables always contains azote. It very seldom happens, however, that any quantity of it can be obtained in a concrete state: it is often dissolved in the last portions of the phlegm. This salt is produced by the union of the azote with the hydrogene of the oil; on which account, it does not usually pass till the end of the distillation. It even appears, that what is carried up by the phlegm in the analysis of some plants, such as the cruciferous plants, poppy, rue, &c. is always the product of some new combination; for Rouelle the younger has shewn, that the plants themselves do not contain it in their natural state.

The elastic fluids which are disengaged during the distillation of vegetables, are to be included among the products that may be obtained from them. Their nature appears to depend on the nature of the vegetable. A plant which contains a good deal of oily combustible fluids, affords hydrogenous gas. Mucilages, on the contrary, afford carbonic acid. We have mentioned, under the article Oxalic Acid, that Messrs Bergman and Fontana have obtained from them a large quantity of carbonic acid, and that Fontana thinks vegetable acids to be composed chiefly of it. It is, therefore, not at all surprising, that mucilages, in which Bergman found the same radical acid as in sugar, should afford carbonic gas when analysed. Lastly, there are some

vegetable

vegetable matters which afford azotic gas. Theſe aeri-
form fluids paſs only towards the end of the proceſs of
diſtillation ; becauſe they are not diſengaged till the in-
ſtant when the vegetable is totally decompoſed. Hales,
who was not acquainted with their nature, obſerved,
that the more ſolid the vegetable, ſo much the greater
was the quantity of the air diſengaged from it during
its diſtillation : and he of conſequence conſidered that
element as the cement which produced the ſolidity of
vegetable bodies. From what we have had occaſion to
ſhew, the reader may eaſily judge of the truth of this
hypotheſis.

CHAP.

C H A P. XX.

Of Vegetable Coal, or Charcoal.

CHARCOAL is the black refidue of vegetable matters, whofe volatile principles have been entirely decompofed in clofe veffels. None but organic matters, containing the combuftible fubftance known by the name of oil, afford charcoal. The production of the fubftance which we are beginning to confider, ufed to be afcribed to the decompofition of this latter fubftance; but it is now beginning to be underftood as a fact, that the carbonaceous matter exifts ready formed in the vegetable; and that which is accomplifhed by the operation of fire, is the feparation of the volatile principles that exifted in union with it.

Charcoal is generally black, brittle, fonorous, and light. If the vegetable of which it has been formed was very compact, and contained but a fmall proportion of fluid fubftance, it ftill retains a vegetable form. But again, when the plant decompofed, is tender, and contains a good deal of juice, the fluids, as they are difengaged, deftroy the organic texture of the vegetable,

and

and leave a friable coal, which exhibits not the form of a decompofed vegetable. Different vegetable matters afford coal in greater or lefs abundance, according to the folidity and the form of their texture. Wood affords much more of this fubftance than herbs; gums afford more than refins; and refins more than fluid oils. Every different vegetable matter appears to contain this fubftance in a particular proportion,—if we confider charcoal as one of the immediate principles of vegetables.

Charcoal is a body poffeffed of fingular properties, which are in general but very little known.—Though it be of the higheft importance in chemiftry, and exhibit phænomena entirely of a fingular nature, yet no chemift has as yet engaged in a feries of experiments with a view to afcertain its nature. Stahl, who paid more attention to it than it has fince obtained from any other perfon, thought it the principal repofitory of phlogifton. We know fcarce any thing concerning the properties of charcoal, but what relates to the œconomical purpofes to which it is applied: the labours of the learned afford no full information concerning it.

The phyfical properties of charcoal are different, according to the nature and the ftate of the vegetables from which it is formed. It is fometimes hard, and retains in fome degree the organization of the vegetable; at other times it is friable, and fomewhat pulverulent. Pure oils afford a coal in very fine, and feemingly levigated molecules, called lamp-black. Its gravity varies in like manner. When well made, it has no perceptible tafte or fmell. Its colour is fubject to as many varieties as its other phyfical properties; it is either of a lighter or a deeper, a fparkling or a dull colour. But the chemical properties

perties of this product of fire, deserve the most particular examination.

Charcoal exposed in close vessels to the utmost violence of fire, suffers no alteration. When heated in a pneumato-chemical machine, it affords no hydrogenous gas, unless it happen to contain moisture: an intense heat reduces it to vapours. When heated in contact with air, it burns to ashes; but with singular phænomena, which are to be carefully distinguished from those of other combustible matters. Assoon as it takes fire, it becomes red, and exhibits a white flame, which is more considerable in proportion as the mass of charcoal is larger. No sort of smoke exhales from it; but it is reduced into carbonic acid, an elastic fluid, which, from the fine experiments of M. Lavoisier, appears to be nothing but a combination of the carbonaceous principle with the oxigenous,—of the latter of which principles three fourths of it consist. It is on this account that charcoal consumes slowly, and leaves nothing but a cinder, more or less white, partly of a saline, and partly of an earthy nature. Different sorts of charcoal are of different degrees of inflammability; and this distinction is the most useful to the arts of all the facts respecting charcoal. Some sorts of it burn readily with flame, and are quickly consumed; others are difficult to kindle, burn but slowly, and remain a long time red-hot, before being reduced to ashes. Some of them,—for instance those of oils,—burn indeed, but with the utmost difficulty. This property they seem to owe to the obstinate adhesion of the carbonaceous principle to the fixed salts of the vegetables.

Charcoal, when exposed to the air, attracts moisture; probably because it is very porous; and perhaps, too, on account of its containing salts in a latent state. When moistened, it affords hydrogenous gas, which is produced
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ced by the decompofition of the water : for, when this
fluid is paffed through an earthen tube, filled with red-
hot charcoal, the two bodies are converted into hydroge-
nous gas and aeriform carbonic acid. Nothing now remains
but a little afhes. Rouelle has taken notice that fixed al-
kali diffolves a pretty confiderable quantity of charcoal by
fufion.

The fulphuric acid, when expofed to a ftrong heat
with powder of charcoal, is decompofed by this combuf-
tible body, which has a ftronger affinity with oxigene
than fulphur has.

The nitric acid is decompofed with much more rapidi-
ty by charcoal. Dr Prieftley obferved that there was a
good deal of nitrous gas produced from this mixture.
Macquer faw the nitric acid, with the help of a certain
degree of heat, produce a very difcernible effervefcence
with this body. M. Prouft has fucceeded in kindling
charcoal with acid of nitre, the weight of which was one
ounce four drams and twenty three grains, in a bottle contain-
ing an ounce of diftilled water. The refult of his experiments
is of no fmall importance : And I fhall therefore here in-
fert an account of it in his own words, taken from his
Obfervations on Pyrophori without alum, &c. inferted in
the *Journal de Medicine* for July 1778.

" A coal of the extract of carthamus, reduced to pow-
" der, and newly calcined, detonized in a very lively
" manner with the nitrous acid ; and the combuftion was
" fo rapid, as to raife the powder in the form of a very
" beautiful fky-rocket. I calcined, likewife, very fine
" powder of common charcoal; and the detonation fuc-
" ceeded very well.

" Into a glafs retort, perfectly dry, I introduced about
" a dram of powder of charcoal; after which I poured into
" the fame retort about as much nitrous acid : the nitrous
" acid

" acid no fooner reached the bottom of the retort, than a
" detonation was produced with the utmoft rapidity. There
" proceeded out of the mouth of the retort, as I held it in
" my hand, a ftream of flame, more than four inches in
" length, carrying with it fome of the powder, and very dark-
" coloured vapours of the nitrous acid : The vapours were
" condenfed into a green and fomewhat fuming liquor,
" which proved to be nitrous acid weakened by the wa-
" ter which entered into the compofition of that which
" detonized firft. I poured a new quantity of nitrous acid
" on the coal which ftill remained in the retort, and con-
" tinued to inflame it in the fame way, till the whole quan-
" tity was exhaufted.

" This experiment I repeated with calcined lamp-black;
" the fame phænomena were exhibited. In the retort
" there remained only a very fmall portion of afhes, fome-
" times half vitrified, and fticking to the bottom of the
" retort.

" All charcoal is ufually impregnated with a confider-
" able quantity of moifture. I found that charcoal cal-
" cined in the evening, was next day unfit for this deto-
" nation, having acquired, during the intervening fpace, a
" fenfible quantity of moifture. But, what is very fingu-
" lar, thefe experiments are fo capricious, that they do not
" always fucceed, even with the fame charcoal, and the fame
" acid, intermixed in the very fame proportions. By the
" following expedient, I believe, fuccefs may be fecured :
" When the acid is poured on the middle of the charcoal,
" it does not take fire at all ; but, again, when the acid is
" made to trickle down the fides of the crucible or cap-
" fule, till it reach the bottom, then detonation infal-
" libly follows, and the powder is raifed and kindled by
" the nitrous acid. When the nitrous acid is all confum-
" ed,

" ed, the detonation ceases of course, and the rest of the
" charcoal remains black."

We know nothing concerning the action of the other
acids on charcoal.

This body, with the help of heat, decomposes all sul-
phuric salts, forming in consequence sulphures with va-
rious bases.

Charcoal causes nitre to detonize; the nitre burns it by
means of the vital air which that saline substance affords
by the action of fire. There is a preparation made for
the purposes of chemistry and pharmacy, which is called
nitre fixed by charcoal. Mix two parts of nitre with one
of powder of charcoal; put the mixture into a red-hot
crucible: A lively detonation immediately takes place:
And, when this detonation ceases, there remains a white
mass which attracts moisture from the atmosphere, and is
nothing else but the fixed alkali of the nitre and the char-
coal combined with carbonic acid. On lixiviating this
matter, the water dissolves the fixed alkali; and what re-
mains, is a substance thought to be of an earthy nature.

Sulphure of potash dissolves charcoal with great facility,
both by the dry and by the humid way: it even combines
with it more readily than any other substance. We owe
this discovery to Rouelle.

Metals do not combine with charcoal; but metallic oxi-
des are reduced when exposed, in contact with this body,
to a heat more or less intense. We have already seen,
under the article of Metals, that this phænomenon is owing
to the near affinity between oxigene and pure carbona-
ceous matter.

The action of vegetable substances on charcoal, has been
but little examined. We know, only, that charcoal mixed
with fat oils, renders them susceptible of inflammation by
the

the nitrous acid; a fact which confirms Rouelle's beautiful theory concerning the inflammation of oils by that acid.

All that has been here said concerning the known properties of charcoal, tends to prove that this body is a compound of a combustible matter, saline substances, and earths.

The peculiar combustible matter which constitutes more than three fourths of the composition of charcoal, or pure carbonaceous matter, is but little known. It appears only to be one of those bodies which have the greatest affinity with oxigene; so great indeed, that it is capable of separating it from every other substance; and that, in certain circumstances, it exhibits properties much the same with those of native *carbure* of iron.

The uses of charcoal in the arts are sufficiently known: it is likewise of great use in chemical operations.

C H A P.

C H A P. XXI.

Of the Fixed Salts and Earths of Vegetables.

WHEN a vegetable coal is burnt, there remains a grey, blackifh, or white matter, according to the nature of the coal. This fubftance, which is called *afhes*, is of a very compound nature. When the charcoal is thoroughly burnt, it contains only different faline and earthy fubftances, mixed with a little iron and a little manganefe. When, again, the charcoal does not burn very freely, the afhes produced from it fometimes contain a little inflammable matter which has not been confumed. M. Lavoifier, on examining the afhes of the wood made ufe of by the manufacturers of faltpetre, found it to contain extractive and refino-extractive matters. The faline fubftances obtained by lixiviation from the afhes of charcoal, have received the name of the Fixed Salts of Plants. There are three forts of falts obtained by the incineration of vegetables, the nature of which we fhall here defcribe.

1. Potafh, which is prepared in the North by burning wood, which they there poffefs in great plenty.

This

This falt is very impure; it often contains combuftible matters by which its whitenefs is impaired, a varie-ty of neutral falts, fuch as fulphate of potafh foda and lime, muriate of potafh and foda, a little carbonate of foda, oxide of iron, and earthy matters. To purify this falt, and extract from it pure potafh, it is diffolved in the fmalleft poffible quantity of cold water. The fluid takes up the alkali, with fome neutral falts; and the earth, charcoal, iron, and fulphate of lime which the potafh frequently contains, are feparated by filtration. The fo-lution is evaporated to a pellicle, and then fuffered to fettle and cool, in order that the different neutral falts which it contains may be formed into cryftals. When, at length, after repeated filtration, evaporation, and cryftallization, the lixivium ceafes to afford neutral falts, it is evaporated to drynefs, and calcined. The falt thus obtained is carbonate of potafh, intermixed with cauftic potafh. It always contains, however, fome neutral falts, and a fmall portion of earthy matters, which may be fe-parated by forming thefe falts and earthy matters into a ftrong folution with water, fuffering that folution to fettle and reft for fome time, and then feparating, by filtra-tion, the fediment thus formed. The potafh may now be ufed with confidence as pure, even in the niceft che-mical experiments.

2. Soda is the refidue remaining after the combu-ftion of certain plants which grow on the fea fhore. It is prepared at Alicant, in Languedoc, at Cherbourg, &c. by the combuftion of various plants. At Ali-cant, the kali is employed; at Cherbourg, the algas and fucus, commonly known by the name of *varech.* The former of thefe plants contains a good deal more foda than the other; which indeed affords but very little. Thefe plants are made very dry, and burnt over a trench.

At Cherbourg, when the combuſtion is conſiderably ad-
vanced, and the aſhes are become very hot, they are
violently ſtirred and kneaded together with large poles.
By this motion, the ſubſtance, being hot enough to ſuf-
fer a ſort of ſemi-vitrification, is formed into ſolid, hard
pieces, which are ſold in commerce under the names of
ſtone-ſoda, ſalicore, ſalicote, la marie, and *alun catin.* The
names by which it is chiefly diſtinguiſhed, and which de-
note its particular ſtate, are thoſe either of the country
from which it comes, or the plant from which it is ob-
tained. The ſoda of Alicant, called alſo *barilla,* is the
beſt for the purpoſes of chemiſtry, and of all thoſe arts
in which fixed alkali is neceſſary.

The ſoda of Cherbourg, or *varech,* contains leſs alkali,
and ſhould not be uſed in chemiſtry ; but in glaſs-works
it is very advantageouſly employed ; for it contains vi-
treous frit, which anſwers the purpoſes of the glaſs-
maker, by promoting the vitrification of the other mat-
ters.

Common ſoda, chemically conſidered, is a compound
of cauſtic ſoda, carbonate of ſoda, a ſmall proportion of
carbonate of potaſh, ſulphate of potaſh and ſoda, muriate
of ſoda, charcoal, iron in the ſtate of *Pruſſian blue,* as
has been obſerved by Henckel, and earth partly free,
partly combined with fixed alkali, as in that of Cher-
bourg. To ſeparate theſe ſubſtances, and obtain the
carbonate of ſoda in a pure ſtate, they are formed into
a lixivium with cold diſtilled water : this lixivium is fil-
trated, in order to ſeparate the earth, the iron, and the
carbonaceous matters : laſtly, it is evaporated in the
ſame way as potaſh. This alkali is more eaſily pu-
rified than potaſh ; for as it cryſtallizes ſooner, it ſepa-
rates more readily from the cauſtic ſoda. It however
carries with it, when it cryſtallizes, ſome of the neutral
                                                          ſalts

falts and the Pruffian blue contained in the lixivium, which can be feparated only by repeated folution, and fucceffive cryftallization.

3. There are fixed falts prepared in pharmacy, which have been ftrongly recommended by Takenius, and ftill bear his name. That chemift's procefs confifts in putting the plant from which the falt is meant to be extracted into an iron pot, and heating that veffel till its bottom become red-hot : the plant is conftantly ftirred, and exhales a good deal of fmoke : at length it kindles : it muft now be covered up with a lid, which may fuffer the fmoke to efcape, but extinguifh the flame. By this means the plant is gradually confumed. When reduced to a fort of blackifh cinder, it is lixiviated with boiling water ; and, on evaporating that lixivium to drynefs, a yellowifh or brown falt is obtained. That falt is often alkaline, but very impure; it contains a good deal of extractive matter from which it derives a colour, and which is mixed with all the neutral falts contained in the plant: it is in a fort of faponaceous ftate, which makes it very fit for being employed in medicine. But we muft not imagine that it poffeffes all the virtues of the plant from which it was extracted ; for the combuftion neceffarily alters the principles of the plant. It would be worth while to examine, by a chemical analyfis, the feveral fixed falts prepared in Takenius's way, in order to difcover what faline and extractive fubftances they contain ; and to afcertain their virtues, and the quantities in which they are to be adminiftered.

4. When the afhes of vegetables are deprived, by lixiviation, of all the faline matters which they contained, the refidue is nothing but a pulverulent fubftance, more or lefs white or coloured, infipid, infoluble in water, and which has been hitherto thought to confift of earths.

The

The magnet attracts iron from this matter. This iron, as well as the manganese which has in like manner been for some time obtained from this residue of vegetables, must have existed ready formed in the plant. A number of naturalists are of opinion, that plants owe their colours to iron. M. Baumé, who, in his memoir on clays, mentions the earthy residue of vegetables, affirms, that it forms, with the sulphuric acid, alum and sulphate of lime a little different from that which owes its formation to pure calcareous earth. From this M. Baumé concludes, that the earth of vegetables consists of clay, and of another earth, nearly of a similar nature with calcareous earths; yet distinct from these, as it does not form quick-lime by the action of fire. He thinks that clay is formed in these substances by the collisions to which siliceous earth is exposed in them, and by the action of the acids with which it combines; and that clay, once formed, passes into the state of calcareous earth, in consequence of undergoing new elaborations in the tubes of vegetables.

We cannot help observing in this place, that the discoveries made in Sweden concerning the saline nature of the bones of animals,—which are to animals precisely what the fibrous texture of plants is to vegetable bodies,—seem to suggest, that the residue of vegetables is any thing rather than an earth. Perhaps an exact analysis, such as has not yet been made, might shew, that what has been taken for an earthy matter, is rather calcareous phosphate; at least we may suspect as much from the experiments of Margraf and M. Berthollet, who have obtained phosphorus from the grains of mustard, from the gluten, and from various other vegetable matters,—as well as from the experiments of M. Haffenfratz, who has extracted phosphoric acid from a great many marsh plants.

<div align="right">C H A P.</div>

C H A P. XXII.

Of Fermentations in general, and of the Spiritous Fermentation in particular.

AFTER confidering vegetables in the ftate in which nature prefents them to our obfervation, we may attend to the alterations and changes which they are liable to fuffer from various circumftances. The alterations depending entirely on their nature, are always the effect of a phænomenon, called *fermentation.*

Fermentation is a fpontaneous motion which arifes in vegetables, and fometimes produces a total change of their properties. This motion is peculiar to the fluids of organic bodies; and no fubftances, but fuch as have been elaborated by the functions of vegetable or animal life, are fufceptible of it. Chemifts have not infifted fufficiently on this important truth, the application of which to the phænomena of organized fubftances is fingularly ufeful in medicine.

There muft feveral circumftances concur to promote this fermentation. Such as,

1. A certain degree of fluidity. Dry fubftances fuffer no fort of fermentation.

2. A more

2. A more moderate or a more intenfe heat. The degrees of heat vary with the forts of fermentation; but cold ftops the progrefs of every kind of fermentation.

Boerhaave, and after him other chemifts, have diftinguifhed fermentation into three kinds: Spiritous fermentation, which produces alcohol;—acetous fermentation, which affords vinegar or acetous acid;—and putrid fermentation, or putrefaction, which produces ammoniac. It is to be obferved, that there are feveral fermenting motions, which cannot be referred to any of thefe three claffes of fermentation.—Such, perhaps, are the fermentations of bread, of infipid mucilages, of colouring matters, &c. It has been thought, that fermentations always fucceed each other in the order in which we have mentioned them: but there are bodies which become acid, without paffing previoufly into the ftate of putrefaction; and, in other inftances, putrefaction·takes place without being preceded by the two other fpecies of fermentation.—We may likewife obferve, that the internal motion of maturation feems to conftitute a fpecies of primary fermentation, which calls forth the faccharine matter from a latent ftate. It is fpiritous fermentation which affords alcohol. In order to become well acquainted with the phænomena of this fpecies of fermentation, we may confider, 1. The conditions neceffary to its production; 2. The phænomena which accompany it; 3. The feveral matters fufceptible of it; 4. The caufe of that internal motion; 5. The product which it forms.

It is well known to chemifts, that all vegetable matters are not fufceptible of fpiritous fermentation, and that, in order to its taking place, feveral different circumftances muft concur. Thefe we are to confider as neceffary conditions of fpiritous fermentation,

<div align="right">Thefe</div>

Thefe conditions are,

1. A faccharine mucilage. No other matter is fufceptible of fpiritous fermentation.

2. A fomewhat vifcous fluidity. Too fluid a juice is no more fufceptible of fpiritous fermentation than one that is too thick.

3. The heat of—from ten to fifteen degrees in Reaumur's, or from fifty-five to fixty-five of Fahrenheit's.

4. A confiderable mafs of matter in which a rapid motion may be excited.

When thefe four conditions concur, fpiritous fermentation then takes place; and certain phænomena invariably accompany it. The following is what I have been able to difcover by obfervation concerning it.

1. A motion is raifed in the liquor, which becomes more and more confiderable, till, at length, the fermentation is fairly eftablifhed through the whole mafs.

2. The bulk of the mixture is confiderably enlarged, in proportion as the motion is communicated through the whole mafs.

3. The liquor lofes its tranfparency, and is rendered turbid by opaque filaments appearing in motion through all parts of it.

4. There is a heat produced, amounting, according to the Abbé Rozier, to eighteen degrees of Reaumur, or feventy-two and one half, Fahrenheit.

5. The folid parts intermixed with the liquor are raifed, and fwim, in confequence of the difengagement of an elaftic fluid.

6. There is a confiderable quantity of carbonic acid gas difengaged. That gas forms a ftratum above the liquor, in the veffel containing it, which may be eafily diftinguifhed from common air. It was on air thus produced, that Dr Prieftley and the Duke de Chaulnes made

their

their fine experiments. It extinguifhes lights, and proves fatal to animals. It produces from lime-water a chalky precipitate: Cauftic alkali it caufes to cryftallize perfectly. This acid is what renders the employment of thofe who are engaged in conducting fermentation fo very dangerous to health.

7. The difengagement of this gas is attended with the formation of a great many bubbles, in the vifcid liquor through which the carbonic acid muft pafs.

All thefe phænomena ceafe by degrees, as the liquor lofes its fweet tafte and faccharine nature, and becomes brifk, pungent, and capable of producing intoxication.

Men have been taught by neceffity to prepare fermented liquors from many different vegetable fubftances. But experience has evinced, that none but faccharine matters are properly fuitable for this purpofe. The faccharine matters which are moft commonly ufed in the preparation of fermented liquors, and which, therefore, beft deferve to be examined here, are the following:

1. The juice of the grape, properly fo called, produces wine, the beft of all fermented liquors. In learning the art of cultivating vines, which is of great importance, it will be proper to examine, 1. The nature of the foil on which the vine grows; a dry parched foil is known to be very favourable to this plant, as it does not thrive well in a ftrong fat foil :—2. The mode of managing and cultivating this vegetable; it is to be pruned, and its branches bent down, to hinder the fap from flowing in its ufual direction. Care muft be taken to have the vine expofed to the fun, particularly to the reflection of his rays from the ground, &c.; and it does not need to be fupplied with any fort of manure, &c. :—3. The hiftory of the vegetation of the vine, its expofure, its flowering, and the formation and ripening of the grape :—4. That

of

of the accidents to which it is liable from froft, rains, moifture: 5. The feafon of the vintage, which fhould be dry and hot. When this previous knowledge is acquired, the art of making wine is next to be confidered; which confifts in putting the grapes, after pulling them, into a veffel expofed to the heat of fifteen or fixteen degrees, and crufhing, ftirring, and turning them: fermentation is then produced, with all its ufual phænomena. The juice of the grape, or muft, fhould not be either too fluid or too thick; when too fluid, it may be thickened by boiling; when too thick, it muft be diluted with water. When the wine is made, it is drawn off, and put into open cafks. It there fuffers infenfibly a fecond fermentation, by which its principles are more intimately combined. It precipitates a fine lye, and a falt known by the name of *tartar*, which we have examined in a former chapter of this volume. To preferve wine, rags dipped in fulphur are burnt in the cafk in which it is contained.

It is farther of importance, to be able to diftinguifh the different forts of wine. France produces a great variety of excellent wines: thofe of Burgundy are the beft for conftant ufe: their principles are fo perfectly combined, that none is predominant over the reft. The vines of the diftrict of Orleans acquire nearly the fame qualities with thofe of Burgundy, when time has mellowed their harfhnefs, and combined the excefs of fpirit or alcohol which they contain. The red wines of Champagne are very excellent, and of a delicate flavour. The white wine of the fame country which does not fparkle, is much better than that which fparkles; for the tafte of the latter is tart and fourifh; and befides, it owes its quality of fparkling to its containing carbonic acid, in confequence of having been bottled before the fermentation

ation had been finifhed. The wines of Languedoc and Guyenne are deep-coloured, and highly tonic and ftomachic ; efpecially when old. The wines of Anjou are ftrongly fpiritous, and therefore foon intoxicate. As to foreign wines ; thofe of Germany known by the name of Rhenifh and Mofelle wines, are white, very fpiritous, and of a frefh poignant tafte : They very foon intoxicate. Some Italian wines, fuch as thofe of Orvietto, Vicenza, and Lachryma Chrifti, &c. are well fermented, and not much inferior to good French wines. Thofe of Spain and Greece are, in general, fweet, crude, imperfectly fermented, and very unwholefome. We muft, however, except thofe of Rota and Alicant, which are defervedly efteemed very ufeful ftomachics and cordials.

2. Apples and pears afford cyder and perry : Thefe are pretty good liquors; and M. D'Arcet has fhown, that brandy may be obtained from them.

3. Cherries afford a pretty good wine, from which that fpecies of brandy which the Germans call *kirchen-waffer* is extracted.

4. Apricots, peaches, and plums afford a fpecies, not quite fo good.

5. Sugar diffolved in water eafily ferments. From this fort of wine, prepared from the juice of the cane, there is a fpirit extracted, which is known by the names of *taffia*, *rum*, *guil dive*, &c.

6. Gramineous feeds, and of thefe efpecially barley, afford a fort of wine, called *beer*. The following are the proceffes of the art of brewing : The barley is fteeped in water for thirty or forty hours, to foften it. It is then laid in a heap, and left in that ftate till it begin to germinate. It is then dried in a kiln ; and the buds are feparated by fifting : after which, it is coarfely ground into what is called *malt*. The malt is put into a veffel,

called

called the *mafh-tun*, and hot water poured upon it to dif-
folve the mucilage. This being drawn off, a fecond
quantity of hot water is poured upon the malt; and in
like manner drawn off. This fluid is called *wort*, and
boiled with hops; after which it is put to ferment, with
yeaft, into a veffel called the *cooler*. When the fermenta-
tion begins to fubfide, the beer is ftirred, and drawn off
into cafks. The fecond fermentation throws up a fcum
called *yeaft*, which is kept for fermenting future brew-
ings. Germination calls forth, from a latent ftate, a cer-
tain faccharine matter in barley, to which malt owes its
property of affording a wine. A fimilar liquor might be
prepared from moft other gramineous feeds.

All thefe facts concur to fhow, that the faccharine
matter is the only principle of vegetables fufceptible of
fpiritous fermentation, and that water is neceffary to the
production of this inteftine motion. M. Lavoifier thinks
that the fluid is decompofed in the operation; its oxige-
nous part combines with the carbonaceous matter of the
fugar to form carbonic acid, which is difengaged during
the fermentation; while the hydrogene, the other prin-
ciple of the water, uniting with the oil of the faccharine
body, forms a very light and fubtle combuftible body,
which contains much lefs carbonaceous matter than fugar,
and is much lighter, and much more inflammable, and
conftitutes what is called *alcohol*.

The product of all thefe fermented fubftances is a pe-
culiar liquor, more or lefs coloured, of an aromatic fmell,
of an hot, poignant tafte; which, when taken in a fmall
quantity, re-invigorates the fibres, and, when drunk in too
great abundance, intoxicates; and is known over all the
world by the name of *Wine*.

The wine of grapes, for inftance, is a compound con-
fifting of a large proportion of water,—an aroma, peculiar

to

to each different fort of wine,—alcohol,—an effential falt, called *tartar*,—and an extracto-refinous colouring matter, to which red wines owe their colour.

Before proceeding to explain the means by which thefe principles may be feparated, it may be proper to give fome account of the properties and ufes of pure unaltered wine. Wine, by means of the water, alcohol, and effential acid falt which it contains, is capable of diffolving a great many bodies. It unites with extracts, refins, certain metals, &c. Thefe are the properties which render wine fit for entering into medical preparations. Thefe preparations are, 1. Emetic wine, which is prepared by macerating four ounces of *crocus metallorum* in two pounds of good white wine. The liquor is filtrated, or rather made ufe of in a turbid ftate, as a powerful ftimulus in cafes of apoplexy, palfy, &c.—2. Chalybeate wine, prepared by digefting an ounce of iron filings with two pounds of white wine. It is an excellent tonic and aperient.—3. Vegetable wines, which are prepared, A, either with red wine, in which aftringent, aromatic plants are macerated ; or, B, with Spanifh wine. Both the wine of fquills, and the liquid laudanum of Sydenham, are prepared with this fpecies of wine. The latter of thefe is prepared by digefting, for a number of days, two ounces of opium cut into flices, an ounce of faffron, and a drachm of cinnamon and cloves, in a pound of Spanifh wine. This mixture, taken in dozes of a few drops, is an excellent calming medicine, efpecially when there is reafon to fear that opium might weaken the patient too much, or might hinder fome ufeful evacuation.

The action of fire is commonly ufed to decompofe wine, and feparate its different principles. The liquor is diftilled in an alembic of copper plated with tin, with a receiver adapted to it. Affoon as the wine is heated to ebullition,

ebullition, it affords a white fluid, in a ſmall degree opaque and milky, of a hot, poignant ſmell, and of a ſtrong, ſweet taſte. This fluid is collected into the receiver, till ſuch time as the vapours exhaling ceaſe to be ſuſceptible of inflammation by the contact of light. This product is what is called *Brandy :* It is a compound of water, alcohol, and a ſmall quantity of oil, which obſcures its tranſparency while it is diſtilled, and afterwards communicates to it a yellow colour. The colour of old brandy is not, however, owing ſolely to this oil which paſſes with it when it is diſtilled, but rather to the extractive matter of that part of the wood of the caſks which it has diſſolved. Alcohol, as we ſhall hereafter ſee, is extracted from brandy. Wine, after affording brandy, aſſumes a deeper colour, and a harſh, acid taſte ; it is alſo turbid, and may be obſerved to contain a great many ſaline cryſtals, which are nothing but tartar. This fluid is now, therefore, totally decompoſed, and its original properties cannot be again communicated to it, by combining the ſpiritous product with the reſidue : The analyſis is therefore complicated. The reſidue of wine from which brandy has been extracted, takes, by evaporation, the form and conſiſtency of an extract. The colouring part may be ſeparated by alcohol, which does not affect the tartar. This tincture is not liable to be precipitated by water. When evaporated to dryneſs, the reſidue readily takes fire, and is ſoluble in water. It is, in its nature, a true reſino-extractive, which the alcohol formed by the fermentation has taken up from the pellicles of the grapes. From this analyſis it appears, that wine is actually compoſed of water, alcohol, tartar, a colouring matter, and an aroma, which is deſtroyed or modified by the action of fire. We already know the nature and properties of moſt of theſe ſubſtances : we have only alcohol to examine.

Before

Before we proceed to ſpeak of this product, it will be proper to ſay ſomething concerning a ſubſtance which is precipitated from wine while it ferments, and is called *lees.* It conſiſts of the ſeeds and ſkins of grapes, impure tartar, and ſulphate of potaſh or vitriolated tartar. It is obtained from brandy by diſtillation with naked fire. When treated in a retort, it affords an acid phlegm, and ammoniac; and its coaly reſidue contains carbonate and ſulphate of potaſh. The lees of wine, incinerated in the open air, afford cauſtic potaſh, mixed with carbonate and ſulphate of potaſh; a ſubſtance known in the Arts by the name of *cendres gravelées.* The particulars which we are to relate concerning the properties of alcohol, will complete what has been here ſaid concerning the properties of lees.

C H A P.

CHAP. XXIII.

Of Alcohol, or the Product of Spiritous Fermentation.

BRANDY, obtained from wine by diftillation with naked fire, is a compound of alcohol, water, and a fmall portion of oily matter. Diftillation is employed to feparate thefe fubftances, and give the alcohol pure. There are feveral proceffes for the diftillation of alcohol. M. Baumé recommends the diftillation of brandy on a balneum-mariæ, to be repeated as often as may be neceffary for the extraction of all the fpirit which it contains. He directs, to feparate the firft fourth part of the product of the firft diftillation, and, in like manner, the firft half of the product of the fucceeding diftillations; then to mix all thefe firft products together, and rectify them by a gentle heat. The firft half of the liquor which paffes in this rectification, is the pureft and ftrongeft alcohol: the reft is a weaker alcohol, but ftill better for ordinary purpofes. Rouelle directs to extract, by diftillation on a water-bath, one half of the brandy made ufe of: this firft product is common alcohol. By rectifying it twice, and reducing it to about two thirds of its original quantity, the ftrongeft alcohol is obtained:

This,

This, according to Kunckel's procefs, is to be again diftilled with water, to feparate the oil by which it is altered. This alcohol, after the diftillation with water, is rectified; and the operator is now certain of its being perfectly pure. The refidue of diftilled brandy is nothing but water impregnated with fome particles of colouring matter, with a peculiar oil floating on its furface.

It may be naturally inferred, that this fluid being prepared by various procefles, will be, at different times, of different degrees of ftrength. Attempts have long been made to difcover fome means of afcertaining its purity. It was at firft thought, that the alcohol which burns readily and leaves no refidue, muft be very pure: But, it is now known, that the heat produced by its combuftion is fufficiently ftrong for extracting all the phlegm which it may contain. Powder has been propofed as a teft of its purity. Alcohol that does not kindle gun-powder, when it is itfelf kindled and applied to it in a fpoon, is confidered as bad; but, if it does kindle the powder, it is thought very good. This proof, however, is fallacious; for when any confiderable quantity, even of the beft alcohol, is poured on a little powder, the water which it affords as it burns, moiftens the powder fo as to hinder it from kindling; whereas, again, the fame powder may be kindled, by burning at its furface a very fmall quantity even of phlegmatic alcohol. This method of proof is, therefore, not more certain than the former. Boerhaave gives a very good procefs for afcertaining the purity of alcohol. It confifts in cafting dry powdered potafh into the alcohol under examination. The potafh enters into union with the fuperabundant water of the alcohol, and forms with it a more ponderous and a higher-coloured fluid, which does not mix with the alcohol, but

<div align="right">finks</div>

finks under it. Laftly, M. Baumé, proceeding upon this principle, that the purer alcohol is, fo much the more does its levity exceed that of water, has contrived an areometer, by means of which the degree of the purity of this, or of any other fpiritous liquor, may be accurately afcertained. When that inftrument is immerfed in alcohol, the purer the fluid is, fo much the deeper does it fink. He has afcertained by a number of accurate experiments, that the pureft and moft highly rectified alcohol gives thirty-nine degrees of his areometer, equal to ten of Reaumur's thermometer. The method of conftructing this inftrument, with the refults which alcohol afforded when mixed with various quantities of water, may be feen in his Elements of Pharmacy, and may be applied to determine the ftrength of fpirit of wine by the hydrometer.

Pure alcohol, obtained by the procefs above defcribed, is a tranfparent fluid, very moveable, and very light, of which fix drachms and forty-eight grains may be contained in a bottle capable of holding an ounce of diftilled water. Its fmell is poignant and agreeable; its tafte hot and pungent. It is exceedingly volatile. When expofed even to a flight degree of heat in clofe veffels, it afcends, and paffes unaltered into the receiver. By this means it is concentrated; and any little water which it might contain, is feparated from it. On this account the firft portions are the fweeteft, the pureft, and the moft volatile. It was formerly thought, that there was a good deal of air difengaged from alcohol when diftilled; but what was thought to be air, is now known to be the fpiritous part of the fluid, which efcapes from the water, and is volatilized in the ftate of gas.

When alcohol is heated, in contact with air, it foon kindles, and burns with a light flame, the middle of which

is white, and the edges blue : if it has been well dephlegm-
ated, it burns in this manner without leaving any refi-
due.   Various chemifts have attempted to difcover what
products alcohol afforded when burnt.   They have afcer-
tained, that its flame is not accompanied with any foot or
fmoke, and that the products volatilized prove to be no-
thing but pure water, infipid, inodorous, and perfectly in
the fame ftate with diftilled water.   This phænomenon
induced Boerhaave to think that the flame was owing to
the water ; and his opinion receives confirmation from what
is at prefent known concerning the hydrogenous gas ob-
tained from the decompofition of water,—and concerning
the compofition of water by the combuftion of the fame
gas with vital air.   M. Lavoifier, on burning alcohol in
a chimney, which was fo conftructed and difpofed as to
collect the vapours, difcovered, that the quantity of water
obtained, is greater than the quantity of alcohol burnt : A
fact from which it appears that alcohol contains a great
deal of hydrogenous gas.   On the other hand, M. Ber-
thollet has remarked, that when a mixture of alcohol and
water is burnt, the fluid refidue precipitates lime water.
This experiment fhews, that alcohol contains a little car-
bonaceous matter, which, by its combuftion, or combina-
tion with oxigene, forms carbonic acid.   Chemifts have
entertained different opinions concerning its nature.   Stahl,
Boerhaave, and feveral others, have confidered this fluid
as a compound of a very fubtle oil, with an attenuated
acid, and water.   According to this opinion, therefore, it
is a fort of acid foap.   Others, at the head of whom Car-
theufer and Macquer deferve to be named, think alcohol
to confift of phlogifton and water.   The true nature of
this liquor is ftill unknown.

   Alcohol, when expofed to the air, is evaporated at the
temperature of ten degrees above the freezing point, and
                                                    leaves

leaves no refidue, except a little water, when it has not been fufficiently dephlegmated. The hotter the atmofphere, fo much the more rapid is this evaporation. It is attended with a greater or a lefs degree of cold, according to its rapidity. At 68 degrees of heat above o in Reaumur's thermometer, 185° Fahrenheit, alcohol takes the form of an elaftic fluid.

Alcohol combines with water in any proportion, and is perfectly foluble in it. This folution is attended with heat, and forms different forts of brandy, the ftrength of which is in proportion to the quantity of the alcohol. So ftrong is the affinity of combination between thefe two fluids, that water is capable of feparating from alcohol many of the other bodies which may be united with it; and again, alcohol decompofes moft faline folutions, and precipitates the falts. On account of its poffeffing this property, Boulduc has propofed the ufe of alcohol to precipitate the falts contained in mineral waters, and obtain them without alteration.

Alcohol does not act on pure earths. We know not whether it be liable to be altered by barytes or magnefia. Lime appears to be capable of producing fome change upon it; for when alcohol is diftilled on that falino-terreous fubftance, the fluid acquires a peculiar fmell. But this phœnomenon has not been fufficiently attended to.

The fixed alkalis actually decompofe alcohol, as is proved by the preparation known in pharmacy by the name of *acrid tincture of tartar.* In preparing this medicine, a quantity of potafh is melted in a crucible, and either pulverized hot, or put into a matrafs: highly dephlegmated alcohol is poured, to three or four fingers depth, upon the falt: the matrafs is clofed with another of a fmaller fize: thefe are luted together, and the whole is digefted on a fand-bath, till the alcohol acquire a reddifh colour. Ei-

ther

ther more or lefs alkali remains at the bottom of the vef-
fel.   By diftilling the acrid tincture of tartar, we obtain
an alcohol of a fweet fmell, but little altered; and there
remains in the retort a matter refembling a faponaceous
extract, which, when diftilled by naked fire, affords alco-
hol, ammoniac, and a light empyreumatic oil.   After this
operation, a little charcoal remains, which is found to con-
tain the potafh.   From this experiment it would appear
that alcohol contains an oil which the fixed alkali feizes,
and forms with it a real foap that is found in the portion
of the alcohol which has not fuffered decompofition.   The
lilium of Paracelfus differs from the acrid tincture of tar-
tar, only in that the fixed alkali employed in the prepara-
tion of it, appears to have been reduced to a cauftic ftate
by the metallic oxides with which it was heated.   The
martial, jovial, and *cupreous* reguli of antimony, of each
four ounces, are fufed together, reduced to powder, and
detonized with eighteen ounces of nitre, and as much tar-
tar : they are urged with fire till they melt ; the mixture
is then pulverized, put into a matrafs, and highly dephlegm-
ated alcohol poured upon it, to the depth of three or
four fingers breadth.   This mixture, digefted on a fand-
bath, affumes a beautiful red colour, deeper than that of
the acrid tincture of tartar, and exhibits all the fame
phænomena.   That tincture may be rendered entirely fi-
milar to the lilium of Paracelfus, by digefting alcohol on
cauftic fixed alkali, inftead of ufing fixed falt of tartar,
which is not entirely deprived of its carbonic acid by the
action of fire, unlefs it be kept for a long time red-hot.
M. Berthollet is convinced that thefe tinctures are no-
thing but folutions of cauftic potafh in alcohol, and that
they afford an happy mode of obtaining that alkali very pure,
as they leave it feparate by evaporation.   Alcohol acts in
the fame way on pure foda.   The acrid tincture of tartar,
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and the lilium, are very good tonics, and powerful difcuf-
fives. They are employed in all cafes in which the na-
tural ftrength of the patient is not fufficient to fupport the
progrefs of his difeafe to a crifis, as in the malignant fe-
ver, fmall-pox of a bad kind, &c.

The action of cauftic ammoniac on alcohol has not yet
been examined.

All the acids exhibit with alcohol phænomena highly
worthy of obfervation. When a quantity of ftrongly
concentrated fulphuric acid is poured on an equal quanti-
ty of rectified alcohol, a remarkable heat and hiffing
take place. The two fubftances become coloured ; and
there is, at the fame time, exhaled from them a fweet
fmell, refembling that of lemons, or the apple called the
golden rennet. If the retort in which this mixture is
ufually made, be placed on a hot fand-bath, with two
large balloons adapted to it, the firft being immerfed in
a veffel full of cold water, the products obtained are,
1. A fweet-fmelling alcohol. 2. A liquor called æther,
of a very fweet fmell, extremely volatile, and whofe
prefence is indicated by the ebullition of the liquor con-
tained in the retort, and by the large ftriæ with which the
fides of the veffel are furrowed. Care muft be taken to cool
the receiver with wet cloths. 3. After the æther, fol-
lows fulphureous acid, the white colour and fmell of
which fhew that it is time to change the receiver, in
order to obtain the æther feparate. 4. There is at the
fame time volatilized a light yellowifh oil, which is
called *fweet oil of wine*. The fire muft be greatly mo-
derated after the æther has paffed ; becaufe the matter
now remaining in the retort is black, and thick, and
fwells confiderably. 5. When the fweet oil is all diftill-
ed, there likewife paffes fulphureous acid, which becomes
gradually thicker, till at laft it is nothing but black and

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dirty

dirty fulphuric acid. 6. Continuing this operation by a moderate fire, the refidue is at length fo much dried as to take the form and confiftency of a bitumen. This bitumen expofed to a very ftrong fire, affords an acid liquor, and a dry, yellowifh fubftance like fulphur. M. Baumé, who has made a long train of experiments on fulphuric æther, has examined this refidue with a great deal of care: He has found in it fulphate of iron, Pruffian blue, a faline fubftance, and a peculiar earth, the nature of which he has not determined. He even afferts, that the yellow fublimate which it affords is nothing but fulphur; and that it remains white and pulverulent, without being kindled on the coals. To thefe particulars we fhall add, that a new quantity of æther may be obtained from the refidue from which æther has been once obtained, by adding to it, according to M. Cadet's procefs, one third part of alcohol dephlegmated by potafh, and diftilling that mixture. Thefe diftillations may be feveral times repeated; fo that from a mixture of fix pounds of fulphuric acid with alcohol, by adding to it fuccceffively fifteen pounds of the latter of thefe fluids, more than ten pounds of good æther may be obtained.

The operation which we have been defcribing, is, by the phænomena which it prefents, one of the moft fingular, and at the fame time one of the moft important, in all chemiftry; as it affords fome information concerning the principles of which alcohol is compofed. There are two opinions concerning the formation of æther; of which it is proper for us to give fome account. Macquer, who, as has been mentioned, thinks alcohol a compound of water with phlogifton, is of opinion, that in the formation of æther, the fulphuric acid feizing the water of the alcohol, brings it nearer in nature

'to oils. Thus, according to this opinion, there paſſes, at the firſt, alcohol a little altered ;—then a fluid of a middle character between alcohol and oil, which is æther ;—and, laſtly, a genuine oil : becauſe the ſtronger the heat employed to obtain the æther, with the greater energy does the ſulphuric acid act on the principles of the alcohol. Bucquet, ſtruck with a ſtrong objection which he made to this theory, namely, its being hard to conceive how the ſulphuric acid, impregnated as it muſt be, from the time when it begins to act upon the alcohol, with a certain quantity of water, abſtracted from that fluid, can, notwithſtanding this dilution, react with ſuch force on another part of the ſame alcohol, as to reduce it into an oily ſtate,—has advanced another opinion concerning the production of æther. He conſidered alcohol as a fluid compounded of oil, an acid, and water. He thought that, when the ſulphuric acid was mixed with alcohol, the reſult of the mixture was a ſort of bituminous fluid, which afforded, by heat, the ſame principles with all the other bitumens,—that is to ſay, a light oil, very odorous, and highly combuſtible, a ſort of naphtha which was æther, and then an oil, leſs volatile, but higher coloured than the former, which is the ſweet oil of wine. We will, in fact, ſee, in examining the properties of æther, that this fluid has all the characteriſtics of a very ſubtle oil, ſuch as naphtha. This theory does not afford a ſufficiently clear explanation of what paſſes in the preparation of æther. It appears, that the alcohol deprives the ſulphuric acid of its oxigene ;—that a part of the hydrogenous principle contained in the alcohol, combines with this oxigene to form water ;—and that the alcohol, after loſing that part of its hydrogene, forms æther. But we are not acquainted with all that paſſes in this operation.

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Æther, obtained by the procefs here defcribed, is not
very pure : It is combined with alcohol and fulphureous
acid.   To rectify it, it is diftilled in a retort, on a fand-
bath, with fixed alkali.   That falt combines with the
fulphureous acid, and the æther then paffes very pure
by the moft moderate heat.   By feparating the firft half
of this product, the æther is obtained in the pureft and
moft highly rectified ftate.

Æther is a fluid lighter than alcohol, of a ftrong fweet
fmell, fufceptible of great expanfion, and of a hot and
pungent tafte.   It is fo volatile, that when ftirred or
fhaken, it is diffipated in an inftant.   When evaporating,
it produces a cold fufficient to freeze water, as M. Bau-
mé has fhewn by his beautiful experiments.   It is re-
duced into a fort of æthereal gas, which burns with ra-
pidity.   Air in which æther is contained, in a ftate of
folution, will pafs through water without lofing its odour
or inflammability.   Æther is very eafily kindled, by being
heated in the open air, or brought into contact with a
burning body; the electric fpark likewife kindles it.   It
difplays a very luminous white flame, and leaves a black,
and feemingly carbonaceous mark on the furfaces of bo-
dies expofed to its flame.   M. Lavoifier has proved, that
carbonic acid is formed during the combuftion of this
liquor; and M. Scheele, that the refidue of æther burnt
on a little water contains fulphuric acid.

Æther, according to the Count de Lauraguais, is dif-
folved in ten parts of water.   The phænomena which
æther is capable of exhibiting with faline fubftances,
have not yet been particularly examined.   We know
only how it reacts on acids.   Lime and the fixed alkalis
do not appear capable of producing any alteration upon
it.   Cauftic ammoniac mixes with it in all proportions,
forming with it a matter, the mixed fmell of which
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might produce very happy effects in spasmodic complaints. The sulphuric acid becomes considerably hot with æther, and is capable of converting a great part of it into sweet oil of wine, by distillation. The fuming nitrous acid excites a considerable effervescence in æther; and æther appears to become higher-coloured, and more oily, and to acquire greater consistency in consequence of the admixture of this acid. When mixed with the muriatic solution of gold, æther retains a part of the metal, acting, it would appear, in the same way as volatile oils, which also retain a part of the oxide of gold. It dissolves volatile oils and resins, like alcohol: And physicians often make use of æthereal tinctures.

Æther is thought a powerful tonic, and a very good antispasmodic medicine. It is administered in hysteric complaints, and in spasmodic colics. It acts very speedily in promoting digestion, when it is retarded by a weakness of the stomach. It must, however, be administered with prudence, for it is known to be dangerous when taken in too great quantities. It is also applied externally, with very happy effects, to remove the headach, and cure burnings, &c. Hoffman, who paid much attention to the combinations of alcohol with the sulphuric acid, made use of a medicine consisting of sweet oil of wine dissolved in alcohol, which he called his anodyne mineral liquor. The Faculty of Medicine of Paris have added æther to that liquor, and have, in their Dispensary, directed it to be prepared by mixing two ounces of alcohol, which passes before the æther, two ounces of æther, and twelve drops of sweet oil of wine. This medicine is employed in the same way as æther, but is greatly inferior in its effects.

The nitric acid acts upon all alcohol with great rapidity. Navier of Chalons is the first who has given an

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eafy and not very expenfive procefs for the preparation
of nitric æther. His procefs is as follows :—Into a very
ftrong bottle' of the manufactory of Séves, pour twelve
ounces of very pure and highly rectified alcohol, and
immerfe it in cold water, or rather in pounded ice : at
feveral different times, ftirring the mixture each time,
add eight ounces of concentrated nitric acid : then clofe
up the bottle with a good cork, covered with leather.
Set this mixture afide, in fome private place, to avoid ac-
cidents from the burfting of the bottle,—which fometimes
happens. In a few hours, bubbles arife from the bottom
of the bottle, are collected in drops on the furface of the
liquor, and form, by degrees, a ftratum of genuine æther.
This phænomenon continues to go on for four, or from
four to fix days. Affoon as the motion of the liquor ap-
pears to have ceafed, the cork muft be pierced with a
pin, in order to the emiffion of a certain quantity of gas,
which would otherwife force its way out by uncorking
the bottle, and carry with it all the æther. When this
gas is difcharged, the bottle may be unftopped, the li-
quor contained in it poured into a funnel, ftopping the
under end of the funnel with the finger, and the fuper-
natant æther feparated from the refidue, and received
into a glafs phial.

Mr Woulfe has given a different procefs for the pre-
paration of nitrous æther. He ufes very large veffels,
which afford room for the reception of the air that is
difengaged. Taking a balloon of clear glafs, fufficiently
capacious to hold eight or ten pints, and terminating in
a neck feven or eight feet long, he places it on a tripod,
high enough to receive under it a chafing-difh. The
neck of the matrafs is to be adjufted to a tubulated ca-
pital, with a glafs tube feven or eight feet long, adapted
to its beak. The lower extremity of the tube is received
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into a balloon with two necks, the lower part of which is drawn out into a tube, and inserted into a bottle. The other neck of this balloon joins the bottles composing Woulfe's apparatus, which we have already repeatedly described. When all these vessels are sufficiently luted together, a pound of rectified alcohol, and as much fuming nitrous acid, is to be poured into the matrass, through the hole perforated in the capital: that hole must then be stopped with a crystal stopper, wrapped in a piece of leather. The mixture becomes immediately exceedingly hot: vapours are disengaged, and pass rapidly along the neck of the balloon; and this vessel being exposed to a heat sufficient to boil the liquor which it contains, a quantity of nitric æther passes into the balloon employed as a receiver. This process, though very ingenious, is attended with several inconvenient circumstances: It takes a long time to set up the apparatus, which is both very expensive, and very troublesome: and it still exposes the operator to danger; for notwithstanding the room afforded in the vessels for the reception of the vapours, yet, so rapidly are they disengaged, that the vessels happen to be pretty often burst, with considerable noise.

M. Bogues, in the year 1773, published another process for preparing nitric æther. He directs to mix, in a glass retort, capable of containing eight pints, a pound of alcohol with a pound of nitric acid, weakened so as to exhibit only twenty-four degrees of M. Baumé's hydrometer;—to adapt to the retort a balloon of the capacity of twelve pints;—to afford a passage to the air, by inserting, at the juncture of the lute, the barrels of two quills;—and to distil the mixture by a very moderate heat, taking care that the retort sink but a little way in the sand-bath. By this means he obtained six ounces of

nitric

nitric æther, of sufficient purity. It appears, from what
the Abbé Rozier has said, that Mitouard followed, since
the year 1770, a process nearly similar to that communi-
cated to the public by M. Bogues. That chemist sub-
jected four ounces of fuming spirit of nitre, with twelve
ounces of alcohol, to distillation in a retort : He placed
the retort gently on the sand-bath ; and by this means,
which appeared to him simpler than any other that had
been recommended, he obtained a quantity of nitric
æther, of the same kind with M. Navier's. Lastly, M. de
la Planche, apothecary at Paris, has contrived two dif-
ferent ways of preparing nitric æther, each of which has
its conveniences. The first consists in putting nitre in-
to a tubulated stone retort, with a large balloon, and
pouring in by the aperture, first, concentrated sulphuric
acid, and afterwards alcohol. The sulphuric acid disen-
gages spirit of nitre, which reacts upon the alcohol, and
forms, almost instantaneously, nitric æther. As æther
prepared in this way might be suspected to be partly sul-
phuric, he afterwards adopted, in preference to this me-
thod, a new process ; which is, indeed, exceedingly inge-
nious : To a tubulated glass retort, into which he had
put six pounds of dry nitre, he joined an adapter, and a
receiver, communicating by a curved tube with an empty
bottle. The bottle, again, by means of a syphon, com-
municated with another bottle, containing three pounds
of the best alcohol. Then, after properly luting the
whole of this apparatus, and placing the retort on a
cinder bath, he poured upon the nitre, through the aper-
ture in the retort, three pounds of concentrated sulphuric
acid,—shut up the retort with a crystal stopper,—urged it
with fire, till it was raised to ebullition,—and maintained it
in that state, till it ceased to emit vapours. On this oc-
casion, the sulphuric acid disengages the acid of nitre,

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one part of which paffes into the receiver, and the reft
into the fecond flafk. At the end of the operation, the
receiver contains fuming nitrous acid, the retort fulphate
of potafh, and the fecond bottle an æthereal liquor.
This æthereal liquor is next diftilled in a retort, with a
fingle balloon, and only two thirds of the product taken
up. This product is diftilled with a fifth part of fuming
nitrous acid, gradually poured upon it, through a long
glafs funnel: of this likewife no more than two thirds
are diftilled off. Laftly, this fecond product is rectified
on potafh; four ounces are, at the firft, taken off; and
then the remaining three fourths. The four ounces are
very pure nitric æther; and the remaining three fourths
a nitrous, anodyne mineral liquor. The refidues of thefe
two rectifications are dulcified fpirit of nitre.

The nitric æther obtained by thefe proceffes, is a yel-
lowifh fluid, equally volatile and fufceptible of evapora-
tion with fulphuric æther. Its fmell is nearly the fame
with that of fulphuric æther, but rather ftronger, and
not fo pleafant. Its tafte is hot, and more difagreeable
than that of fulphuric æther. It contains a fmall quanti-
ty of fuperabundant acid. It caufes the corks to ftart
from the phials in which it is inclofed; a large quantity
of gas being conftantly difengaged from it. It burns
with a brighter flame, and a thicker fmoke than fulphuric
æther, and does not leave juft fo large a proportion of
carbonaceous refidue. Laftly, like fulphuric æther, it takes
up gold from a folution of that metal, and becomes char-
ged with a certain quantity of it.

The refidue of nitric æther is of a lemon-yellow co-
lour; its fmell is acid and aromatic; its tafte pungent,
like that of diftilled vinegar. According to M. Baumé,
it affords, by diftillation, a clear liquor, the fmell of which
is not fo fweet as that of nitric æther, and its tafte an a-
greeable

greeable acid. It reddens fyrup of violets, combines with water in any proportion, and effervefces with carbonate of potafh. There remains in the retort, after this liquor is diftilled off, an amber-yellow matter, friable, and fimilar in its appearance to real amber, which attracts moifture from the atmofphere, becomes pitchy while it continues expofed to it, and diffolves in water without rendering it mucilaginous.. This fubftance, which M. Baumé calls gummi-faponaceous, affords, in the retort, a few drops of an acidulated liquor, which is very clear, of an oily confiftency, and a light empyreumatic fmell. After the diftillation, there remains a fpongy coal, which is brilliant, infipid, and very obftinately fixed in the fire. Bucquet fays, that the liquor which remains after the formation of nitric æther, takes, by evaporation, a mucilaginous confiftency; and that, in a longer or a fhorter fpace of time, there are faline cryftals formed in it, which bear a confiderable refemblance to hairy caterpillars, and are called *cryftals of Hiærne*, from the name of the chemift who gave the firft defcription of them.— This refidue has been difcovered to be oxalic acid; and the radical principle of that acid appears therefore to be contained in alcohol.

The muriatic acid does not act in any perceptible manner on alcohol. This acid is only dulcified by fimple mixture with this liquor, as are alfo the two others, when mixed in a fmall proportion with alcohol. M. Baumé, in his differtation on æther, mentions his having obtained a little muriatic æther, by bringing vapours of muriatic acid into contact with vapours of alcohol.— Ludolf and Pott employed fublimated muriate of antimony with this view. Baron Bornes directs to diffolve oxide of zinc in muriatic acid, and to diftil that falt, after concentrating it by evaporation in clofe veffels with alcohol.

alcohol. This is an easy enough way of obtaining muriatic æther. But nobody has paid so much attention to this object as the Marquis of Courtanvaux. His process is, to pour into a glass retort a pint of alcohol, with two pounds and a half of muriate of tin, or *fuming liquor of Libavius*. A very strong heat is thus excited; and there arises a white suffocating vapour, which disappears when the mixture is stirred. An agreeable smell then exhales from it, and the liquor takes a lemon colour. Place the retort on a hot sand-bath: join to it with luting two balloons; and let the most distant of the two be immersed in cold water. The first product which passes is dephlegmated alcohol; after it the æther ascends. The ascent of the æther may be distinguished by its sweet smell, and the striæ which it forms on the sides of the retort. When the smell changes, and becomes strong and suffocating, the receiver must be changed, but the distillation still carried on. The product now obtained, is first a clear acid liquor, with some drops of mild oil swimming on its surface; next, a yellow matter, of the consistency of butter, which is a true muriate of tin; and, lastly, a brown, ponderous liquor, which exhales a considerable quantity of white vapours.—There remains in the retort a grey pulverulent matter, an oxide of tin. The æthereal product must now be poured into a retort, upon a quantity of potash: The phænomena which follow are, a lively effervescence, and a copious precipitation, both owing to the tin which the acid has carried up with it, when distilled. By adding a little water, and distilling the contents of the retort by a moderate heat, a product is obtained, equal to about one half of the former æthereal product. All the liquors which pass after the muriatic æther, are strongly impregnated with oxide of tin: They attract moisture from the atmosphere, and combine

with

with water, without affording any precipitate. It was not known to what caufe the rapidity with which the muriatic acid contained in the fuming liquor acts upon alcohol, while the pure acid does not act upon it at all, fhould be afcribed; but from a difcovery of Scheele's, it appears that it is owing to the acid being then in the ftate of oxigenated muriatic acid, in confequence of which the excefs of oxigene which it contains, converts the alcohol into æther. This theory was firft advanced by myfelf, in the year 1781; and has been fince confirmed by the experiments of Meffrs Berthollet and Pelletier.

M. de la Planche, apothecary, has propofed the preparing of muriatic æther, by pouring into a tubulated retort fulphuric acid and alcohol upon decrepitated muriate of foda. The muriatic acid gas, difengaged by the fulphuric acid, upon entering the receiver, comes into contact with the alcohol in a vaporous ftate, and combines with it. The refult of the combination is, an æthereal acid, which, by rectification on fixed potafh, becomes pure æther. It appears, that in this procefs, the muriatic acid deprives the fulphuric acid of a part of its oxigene.

Muriatic æther is highly tranfparent and volatile. It has nearly the fame fmell with fulphuric æther. It burns in the fame way, and affords a fimilar fmoke. It differs from it, however, in two properties: Muriatic æther exhales, as it burns, an odour equally pungent and lively with that of the fulphureous acid; and it has a ftiptic tafte like alum. Thefe two phænomena indicate this æther to be of a different nature, and poffibly lefs perfect than the two preceding forts of æther. No doubt, when its properties are more minutely examined, it may be found diftinguifhed by other more remarkable peculiarities.

After

After this account of the manner in which thefe three mineral acids act upon alcohol, we are to proceed with the hiftory of this fluid. Little attention has been paid to the action of the other acids on alcohol. We know only, that it combines readily with the boracic acid; that in confequence of combination with that acid, it burns with a green flame; and that alcohol abforbs a quantity of carbonic acid gas, more than equal to its own bulk. As to the neutral falts, Macquer has afcertained, that this fpirit diffolves fulphuric neutral falts, but with great difficulty; that nitric and muriatic falts combine with it much more readily; and that the lefs intimately the acid is combined with the other principle of thefe fubftances, the more of them does the fpirit ufually diffolve. Alcohol, boiled on fulphate of potafh and foda, diffolved none of either of thefe neutral falts. Neither does carbonate of potafh, or of foda, unite with it: Moft ammoniacal falts combine with it. Deliquefcent, earthy falts, fuch as calcareous and magnefian nitrate and muriate, diffolve very readily in it. Some metallic falts are alfo very foluble in alcohol; fuch as, fulphate of iron in mother-water, nitrate of copper, muriate of iron and of copper, oxigenated muriate of mercury, or corrofive fublimate. All cupreous falts caufe alcohol to burn with a beautiful green flame. M. de Morveau has fince given a fuller table of the different degrees in which falts are foluble by alcohol, which is inferted in the *Journal de Phyfique.*

Alcohol does not diffolve fulphur, either in maffes or in a powder; but thefe two bodies unite, if brought into contact when they are both in a vaporous ftate, as has been difcovered by the Count de Lauraguais. His procefs confifts in putting fulphur in powder into a glafs cucurbite, putting into the fame veffel, above the flowers of fulphur, a bottle filled with alcohol, and heating

the cucurbite on a fand-bath, with a capital and a re-
ceiver adapted to it.   Both the fulphur and the alcohol
are volatilized at the fame time : They combine, and
pafs into the receiver, in a fluid which is fomewhat tur-
bid, and diffufes a fœtid fmell.   It contains about a grain
of fulphur to the drachm of alcohol.   I have difcovered,
that the fame combination may be produced by diftilling
fulphureous waters, fuch as the water of Enghien, with
alcohol.

Ardent fpirit, or alcohol, does not act at all, on either
metallic matters, or their oxides.   It diffolves amber in
part : It produces no effects on black carbonaceous bi-
tumens.   It is obferved, that it combines beft with am-
ber, after being diftilled on fixed alkali ; and that fixed
alkali, mixed with this bituminous fubftance, renders it
much more foluble, by reducing it, no doubt, to a fapo-
naceous ftate.

There are few vegetable matters on which alcohol
does not act with more or lefs energy.   It deftroys the
colouring part, and frequently the whole fubftance of
extracts, when they are of an extracto-refinous, or a
refino-extractive nature : the faccharine and faponaceous
extracts combine with this fluid.   Margraf has obtained,
by alcohol, a faccharine effential falt from red beet, fkir-
ret, parfnip, &c.   But the matters with which it com-
bines the eafieft, are volatile oils, the aroma, camphor,
balfams and refins.   Alcohol impregnated with the aro-
ma of plants, is improperly called *diftilled fpiritous waters.*
To obtain thefe fluids, diftil alcohol on a balneum-mariæ
with odorous plants.   The liquid takes up the odorous
principle, and is volatilized with it, carrying off, at the
fame time, a certain quantity of volatile oil, which caufes
it to become white with diftilled water.   But the cleagi-
nous principle may be feparated, by rectifying it on a
                                                    water-

water-bath by a very moderate heat; and care muſt be taken, that no more than three-fourths of the alcohol employed be drawn off, left ſome other ſubſtance, beſides the aroma, ſhould be volatilized with it. The ſmell of theſe diſtilled ſpiritous waters becomes more and more agreeable as they grow older; and it appears, that the odorous principle combines more intimately with the alcohol, the longer they are in union.

So great is the affinity between the aroma and alcohol, that alcohol detaches it from volatile oils and water.— When alcohol is diſtilled on volatile oils, and on water impregnated with the odorous principle of a plant, the alcohol ſeizes the odorous principle, leaving the oil and the water deſtitute of ſmell. It is obſerved, that alcohol diſſolves thick and ponderous volatile oils, more readily than ſuch as are very light and fluid. Water ſeparates the principles of this compound: It precipitates the oil in the form of opaque, white globules; but the aroma ſtill remains combined with the alcohol. This liquid eaſily diſſolves camphor in a cold ſtate; but it diſſolves ſtill a greater quantity of it when aſſiſted by the action of heat. This ſolution, in the proportion of two drachms of camphor to the ounce of alcohol, with water added, drop by drop, affords a cryſtalline vegetative figure, which has been obſerved by M. Romieu: It is a perpendicular filament, with needles riſing upon it, under an angle of ſixty degrees. This experiment ſucceeds but ſeldom; as it is ſo very difficult to employ preciſely the proper quantity of water, the proper degree of cooling, &c.

Compounds of oily or reſinous juices with alcohol, in which the alcohol is ſo ſtrongly charged with the oleaginous or reſinous juice as to be coloured by it, and to afford a copious precipitate in water, are called *tinctures;*

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elixirs;

elixirs, balfams, quinteffences, &c. Like diftilled fpirit-
ous waters, thefe are either fimple, as when there is on-
ly one matter diffolved in them, or compound, when they
contain feveral matters together. Thefe medicines are
generally prepared by expofing the juice in powder, or
the plant, the volatile oil or refin of which is to be dif-
folved, to the action of alcohol, affifted by ftirring, and
by the gentle heat of the fun or a fand-bath. To ex-
tract the refins, or any other vegetable matters from fe-
veral different plants at once, care muft be taken, firft
to digeft the matter which is the leaft liable to be affect-
ed by the action of the alcohol, and then to expofe to it,
fucceffively, the other fubftances over which it has greater
power. When the menftruum is charged with as much
of thefe matters as it can receive, it is ftrained off.
Sometimes a compound tincture is prepared at once, by
mixing together feveral fimple tinctures. In this man-
ner, the *elixir proprietatis* is prepared, by mixing the
tinctures of myrrh, faffron, and aloes. Refins and bal-
fams may be feparated from alcohol by pouring water
upon the tinctures, or diftilling them; but in either of
thefe cafes, the alcohol retains the odorate principle.
Water is not capable of decompofing tinctures formed
with extracto-refinous, or refino-extractive matters, fuch
as thofe of rhubarb, faffron, opium, gum-ammoniae, &c.;
for thefe matters are equally foluble in both the menftrua.

   Alcohol and brandy are very generally ufed, and ap-
plied to a great variety of purpofes. The laft of thefe
liquors is drunk as a cordial, to revive the exhaufted fpi-
rits; but in excefs it is dangerous, for it dries up the
fibres, and occafions fhaking, palfy, and dropfy. Al-
cohol, either pure or mixed with camphor, is ufed to
ftop, by external application, the progrefs of gangrenes.

   Diftilled fpiritous waters are adminiftered in medicine,
as tonics, cordials, antifpafmodics, ftomachics, &c. They
are

are given either diluted in water, or fweetened with fyrups.

Of thefe waters with fugar, there are certain drinks prepared, which are known under the name of *ratafias*, or *liqueurs*. Thefe drinks, when properly prepared, and taken in fmall quantities, may be of fervice; but they commonly agree with very few people, and are hurtful to very many. Thefe liquors, taken in excefs, are extremely dangerous to the human conftitution. In-ftead of invigorating with new ftrength, and fortifying the tone of the ftomach, as they are commonly thought to do, they produce, moft frequently, a quite contrary effect. Thofe which, drunk but feldom, and with great moderation, are the leaft injurious, are prepared cold, with one part of alcohol diftilled upon the aromatic fub-ftance which is to afford the flavour, two parts of wa-ter, and one of the fineft fugar.

Tinctures have nearly the fame virtues with diftilled fpi-ritous waters, but they act with much more energy; and therefore, they are to be ufed in much fmaller quanti-ties, and given in wine, in potions, and even in aqueous liquors. The precipitate which they yield in the laft of thefe, is equally fufpended through the mixture, and, befides, the odorous part remains diffolved in the alcohol.

Laftly, alcohol, combined with the copal refin, with oil of afpic, or the greater lavender, or with oil of tur-pentine, forms *varnifhes*, which are called *drying;* be-caufe, when a coat of this compound is laid on any body to varnifh it, the alcohol is foon volatilized, and leaves on the varnifhed body a tranfparent, refinous plating. The volatile oils, which are mixed with this compofition, hin-der the varnifh from drying too haftily, and, by commu-nicating to it fomewhat of an unctuous nature, render it lefs brittle than it would otherwife be.

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<div align="right">C H A P.</div>

C H A P. XXIV.

Of Acetous Fermentation, and of the Acetous and the Acetic Acids.

MANY vegetable fubftances are fufceptible of acetous fermentation. Of this kind are gums, and amylaceous fæcula diffolved in boiling water; but fpiritous and fermented liquors poffefs this property in the moft eminent degree. Acid fermentation may be excited in any of thefe fluids, by expofing them to the action of heat and air at the fame time, fo as to convert them into what is called *vinegar*. This liquor is chiefly prepared from the wine of grapes; but very good vinegar might be alfo prepared from cyder, perry, * &c.

There are three conditions neceffary to vinous fermentation: 1. A heat of twenty or twenty-five degrees of Reaumur's thermometer, or from 75° to 90° of Fahrenheit's: 2. A fubftance at once vifcous and acid, fuch as mucilage and tartar: 3. The contact of air. The change which wines undergo, when converted into vinegar,

* Vinegar is made in Britain from wort, the infufion of malt,

gar, can be attributed to nothing but an inteſtine motion excited in thoſe bodies, in conſequence of their containing a certain quantity of mucilaginous matter, unaltered, and ſtill ſuſceptible of another fermentation. The preſence of an acid matter, ſuch as tartar, is requiſite to produce acid fermentation. Laſtly, the contact of air is indiſpenſibly neceſſary ; and it appears,—it has indeed been proved by the Abbé Rozier, that the liquor abſorbs a portion of air while it ferments.

All kinds of wine are equally good for making vinegar. The worſt are preferred, becauſe they are the cheapeſt. But the experiments of Beccher and Cartheuſer ſhew, that generous wines, not deſtitute of ſpirit, afford generally the beſt vinegar.

Boerhaave, in his Elements of Chemiſtry, has given a very good proceſs for the preparation of vinegar. Take two caſks : at ſome diſtance from the bottoms of theſe caſks, form within each of them a falſe bottom of wickerwork : upon that falſe bottom ſpread grape-ſtalks and vine-branches ; pour upon theſe wine, till one of the caſks be entirely full, and the other half full. The fermentation will firſt begin in the latter : when it is fairly commenced, fill up that caſk with wine from the other : by this means the fermentation is moderated in the full caſk, and begins in the other. After it has continued for a due length of time, fill up the latter caſk again from the caſk in which the fermentation firſt began :— thus the fermentation is again excited in the former, and becomes languid in the other. The two caſks are to be thus ſucceſſively filled up and emptied till ſuch time as the vinegar be entirely formed ; which is not, uſually, in leſs than fifteen days.

In obſerving the phænomena of this fermentation, we perceive a good deal of boiling and hiſſing :—The liquor

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.becomes

becomes hot and turbid ; and a great many bubbles and filaments appear to run through it in all directions: there exhales from it a lively, acid smell, which is in no way dangerous : it abforbs a great deal of air. There is a neceffity for ftopping the fermentation every twelve hours : by degrees thefe phænomena difappear ; the heat falls, the emotion ceafes, and the liquor becomes clear. It depofites a glareous fediment, in reddifh flakes which ftick to the fides of the cafks. It appears, from a fuffi-cient number of experiments, that the fmaller the quan-tity of the wine, and the more it is expofed to the con-tact of air, fo much the more readily does it pafs into the ftate of vinegar. Care muft be taken to draw off the vinegar clear, when it is thus prepared, in order to fepa-rate the lye, which, were this precaution neglected, would caufe it to pafs into the ftate of putrid fermentation.— Vinegar does not, like wine, depofite tartar, by reft : that falt was diffolved, and combined with the alcohol and water, during the fermentation. It is even probable, that the prefence of falt has a principal influence in call-ing forth the properties of vinegar from a latent ftate. This vinegar is of a lighter or an higher colour, according to the nature of the wine from which it is prepared : but even the lighteft coloured vinegar is generally much higher coloured than any fort of white wine ; becaufe the colouring part of the tartar which has been called forth from a latent ftate by the production of the acid, is dif-folved in it.

Vinegar prepared in the manner above defcribed is ex-tremely fluid, of an acid, fpiritous fmell, and of a tafte in a greater or a lefs degree four. It reddens blue vege-table colours. When expofed to a moderate heat, in veffels indifferently ftopped, it is altered, lofes its fpiritous part, depofites a great deal of mucilaginous flakes and

<div align="right">filaments,</div>

filaments, and affumes a putrid tafte and fmell. M. Scheele has fhewn, that it muft be boiled for a few minutes, in order that it may be preferved unfpoiled.

When vinegar is diftilled by naked fire in a ftone cucurbite covered with a capital, or in a glafs retort on a fand-bath, it affords a phlegm of a lively and agreeable fmell, fcarcely acid ; to which immediately fucceeds a very white, and ftrongly odorous acid liquor : this is diftilled vinegar : What follows is lefs odorous, but more acid ; and the farther the procefs advances, the more acid does the product become.—Thefe feveral products may be taken feparately ; by which means, fo many different forts of diftilled vinegar will be obtained, of various degrees of acidity and fmell. The operator muft be fatisfied with obtaining two thirds of the liquor which forms the pureft vinegar. The portion which paffes after that, is more acid ; but it has an empyreumatic fmell, which may be removed by expofing it to the air. It likewife acquires a faint colour. This operation fhews the acetous acid to be more ponderous than water. The refidue is thick, and of a dirty, deep red colour. It depofites a certain quantity of tartar, and is, in an high degree, acid.— Evaporated over an open fire, it takes the form of an extract ; and if, when dry, it be diftilled in a retort, it affords an acid, reddifh phlegm, an oil which is at firft light and coloured, but becomes afterwards ponderous, with a little ammoniac.—The refidual coal, now left, contains a confiderable proportion of fixed alkali.

Vinegar may be concentrated by expofing it to froft.— That portion which ftill remains liquid, becomes highly acid, and is decanted off. The frozen part is almoft entirely water. Only a very little vinegar is obtained by this operation.

The acid of vinegar, when feparated from tartar and

<div align="right">from</div>

from its colouring part by diſtillation, is ſuſceptible of combination with a great number of bodies.

It combines only in an imperfect manner with alumi-nous earth, and forms with it needled cryſtals, the pro-perties of which are but very little known. The name of this ſalt (in the new Nomenclature) is *Acetite of alu-minous earth.*

It combines readily with ammoniac, affording in the combination a ſalt, which is extremely ſoluble in water, and does not cryſtallize, but affords, by evaporation, a viſcid, deliqueſcent maſs. Acetite of magneſia is decom-poſable by fire, by mineral acids, by barytes, by lime, and by the three alkalis.—It is very ſoluble in alcohol.

The acetous acid combines with lime ; and decompoſes chalk, diſengaging its acid in the form of an elaſtic fluid.— The ſalt which it forms with lime, cryſtallizes into very fine needled cryſtals, of a gloſſy appearance, like ſatin.— Calcareous acetite is four and bitter : it effloreſces in the air. It is decompoſed by fire ; by fixed alkalis, which ſe-parate the earth ; and by mineral acids, which diſengage the acid.

The combination of the acetous acid with potaſh, is improperly called, in the laboratories, *foliated earth of tartar :* it ſhould be denominated, *acetite of potaſh.* In preparing this ſalt, a quantity of very pure diſtilled vine-gar is poured upon carbonate of potaſh, prepared by the incineration of tartar ; the mixture is ſtirred ; and vine-gar is poured in, till the ſalt be fully diſſolved, and the two ſubſtances mutually ſaturated :—there ſhould rather, indeed, be an exceſs of the acid.—This liquor is filtrated, and evaporated by a very moderate fire, in a veſſel of porcelain or pure ſilver, When it becomes thick, the evaporation is continued on a water-bath till it be quite dry. By this means a very white ſalt is obtained.—If

expoſed

expofed to too much heat, it takes a grey or a brown co-
lour, becaufe a portion of the vinegar is burnt.—Some
chemifts affirm, that acetite of potafh may be obtained in
a regular form, by fuffering the evaporated folution to a
thick pellicle.

Acetite of potafh is of a pungent, acid, urinous tafte.—
By the action of fire it is decompofed, fo as to afford, in
the retort, an acid phlegm, an empyreumatic oil, ammo-
niac, and a large quantity of ftrong-fmelling gas, confift-
ing of carbonic acid, with hydrogenous gas. The re-
fidual coal contains a good deal of naked potafh.—This
falt ftrongly attracts the moifture of the atmofphere, and
is very foluble in water. The fulphuric acid decompofes
it. To effect this decompofition, one part of concentrated
fulphuric acid is poured on two parts of acetite of potafh,
introduced into a tubulated glafs retort, with a receiver
fitted to it. There is inftantly difengaged, with a lively
effervefcence, a vaporous fluid, of a poignant fmell, which,
in the receiver, condenfes into acetic acid, the *radical*
principle of *vinegar*. This vinegar is highly concentrated,
and ftrongly acid, but not pure, and always mixed with
a certain quantity of fulphureous acid, which may be di-
ftinguifhed by its fmell.—The tartareous acidulum like-
wife decompofes acetite of potafh ; becaufe it has a nearer
affinity than the acetous acid with the alkaline bafe of
this falt.

Vinegar enters into a perfect combination with foda,
and forms with it a falt which has been improperly called
cryftallizable foliated earth : We give it the denomina-
tion of *acetite of foda.* The only difference between
this falt and acetite of potafh, is, that it cryftallizes in
ftriated prifms, much like thofe of fulphate of foda, and
does not attract moifture from the atmofphere. To ob-
tain it in regular cryftals, its folution muft be evaporated

to a pellicle, and then set in a cool place. Acetite of foda, like acetite of potafh, is decompofable by fire, and by mineral acids. To thefe particulars we may add, that when calcareous and alkaline acetous falts are diftilled by a ftrong fire, the refidues which they leave are fo many pyrophori, and burn when expofed to the air. M. Prouft, to whom we owe thefe difcoveries, thinks the divifion of a carbonaceous refidue, by an earth or a metallic oxide, to be the only condition neceffary to the production of a pyrophorus.

The acid of vinegar forms, with ammoniac, a liquor that is called *fpirit of Mendererus*, and is, properly, ammoniacal acetite. This falt is fo volatile that it cannot be evaporated without a great part of it being loft; yet, by flow evaporation, it may be obtained in needled cryftals which are of a hot pungent tafte, and very fpeedily attract moifture from the atmofphere. Ammoniacal acetite is decompofed by the action of fire; by lime and alkalis, which difengage the ammoniac; and by mineral acids, which feparate the acetous acids.

Vinegar acts upon almoft all metallic fubftances; and exhibits, in its combinations with them, a number of very important phænomena.

It does not appear that this fluid is capable of effecting an immediate folution of oxide of arfenic ; but that oxide, by diftillation with equal parts of acetite of potafh, afforded M. Cadet and the chemifts of the academy of Dijon, a fuming liquor of a very ftinking fmell, very tenacious, and of a very fingular nature. M. Cadet firft obferved this liquor to be capable of inflaming fat lute. The academicians of Dijon, wifhing to examine a yellowifh matter of an oleaginous confiftency, which they found accumulated in the bottom of a bottle containing arfenico-acetous fuming liquor, decanted off a part of the fu-

pernatant

pernatant liquor, and poured the reſt on a paper filter. Only two or three drops had paſſed, when ſuddenly there aroſe a very thick ſmoke, of a nauſeous ſmell, which formed a column extending from the veſſel to the cieling of the room : a ſort of ebullition took place around the edges of the matter, and from it there aroſe a beautiful roſe-coloured flame, which continued to burn for ſeveral ſeconds. A particular account of theſe elegant experiments may be ſeen in the third volume of the *Elements of Chemiſtry* of Dijon. They compare the liquor of which we are ſpeaking to a liquid phoſphorus : We take it to be a ſort of pyrophorus, as well as ſome others of which we are hereafter to ſpeak. The reſi-due remaining after the diſtillation of acetite of potaſh, with oxide of arſenic, conſiſts chiefly of potaſh.

Vinegar diſſolves oxide of cobalt : the ſolution is of a pale roſe colour.

It acts neither on biſmuth, nor on its oxide ; but diſ-ſolves oxide of manganeſe.

It accompliſhes a direct ſolution of nickel, according to M. Arwidſſon. This ſolution affords green cryſtals, of the form of a ſpatula.

This acid does not act upon antimony ; but it appears to diſſolve the vitreous oxide of that ſemi-metal ; for An-gelus Sala made up an emetic preparation of theſe two ſubſtances.

Both zinc and its oxide diſſolve very readily in diſtilled vinegar. M. Monnet obtained, by evaporating this ſolu-tion, cryſtals in the form of broad plates. Acetite of zinc fulminates on the coals, and gives out, on the occaſion, a faint blueiſh flame. It affords, by diſtillation, an inflam-mable liquor, a yellowiſh oily fluid, the colour of which ſoon changes to a deep green, and a white ſublimate, which burns by the light of a taper, with a beautiful blue flame.

flame. The refidue is in the ftate of a fcarcely combuf-
tible pyrophorus.

The acid of vinegar does not diffolve mercury in a me-
tallic ftate. This combination may, however, be effected,
by attenuating the mercury into very fmall particles, in
the manner of Keyfer. Mercury, in the ftate of oxide,
combines eafily with vinegar. The only thing neceffary
to produce this combination, is, to boil the acid upon the
red oxide of mercury, called *precipitate per fe*, upon *tur-
bith*, or upon mercury precipitated by potafh from a ni-
tric folution of that metal. The liquor becomes white,
but regains its tranfparency while boiling. It is filtrated.
By cooling it precipitates filver-coloured cryftals in the
form of fparkling fcales, refembling the cryftals of the
boracic acid. This acetite of mercury has obtained the
name of *mercurial foliated earth.* It is prepared in an
inftant, by pouring a nitric folution of mercury into a fo-
lution of acetite of potafh. The nitric acid combines with
the fixed alkali of the latter of thefe falts, and forms
with it nitre, which remains diffolved in the liquor : and
the oxide of mercury, combining with the acid of vine-
gar, is precipitated in brilliant fcales. This mixture is
filtrated; and the acetite of mercury then remains on the
filter. This falt is decompofed by the action of fire. Its
refidue affords a fort of pyrophorous. It is eafily altered
by combuftible vapours.

Tin fuffers but very little alteration from vinegar.
This acid diffolves only a very fmall portion of the metal.
The folution afforded M. Monnet, by evaporation, a yel-
lowifh fubftance refembling gum, and of a foetid fmell.

Lead is one of thofe metals on which the acid of vine-
gar acts with the moft powerful energy. It diffolves that
metal with the greateft facility. Plates of lead, expofed
to the fteam arifing from hot vinegar, are covered over
with

with a white duft, which is called *ceruse*, and is nothing
but pure oxide of lead. This oxide, ground with one
third part of chalk, forms what is ufed in painting under
the name of white lead. To faturate vinegar with lead,
the acid is poured upon *ceruse* in a matrafs. This mixture
is digefted on a fand-bath. After remaining in digeftion
for feveral hours, the liquor is filtered and evaporated to a
pellicle. It affords, by cooling and reft, white cryftals,—
in the fhape of irregular needles, if the liquor was too
much concentrated,—or of flat parallelipipeds, terminating
in two floping furfaces, when the procefs of evaporation
is properly conducted. This acetite of lead is called *fal*
or *faccharum Saturni*, on account of its faccharine tafte.
Its tafte is likewife ftiptic. A fimilar falt is prepared of
litharge and vinegar. Equal parts of the two fubftances
are boiled together till they be mutually faturated; and
this mixture, after being evaporated to the confiftency of
clear fyrup, forms M. Goulard's *extract of Saturn*, which
was known, long before his time, by the name of *vinegar
of Saturn*. Acetite of lead is decompofed by heat. It
affords an acid liquor, which is ruddy, and ftrongly fœ-
tid, but very different from radical vinegar, or the pure
acetic acid of which we are foon to fpeak. The refidue
is a very good pyrophorus. This falt is decompofed by
diftilled water, by lime, alkalis, and mineral acids. The
extract of Saturn, diluted in water, and mixed with a
little brandy, forms the *vegeto-mineral* water.

Vinegar diffolves iron with confiderable energy. The
effervefcence which takes place in this folution is owing
to the difengagement of hydrogenous gas from the wa-
ter which appears to be diffolved. The liquor affumes
a red or brown colour. By evaporation it affords no-
thing but a gelatinous magma, mixed with a few oblong
brown cryftals. Acetite of iron has a ftiptic fweetifh

tafte.

tafte. It is decompofed and deprived of its acid by fire.
It attracts moifture from the atmofphere, and is decompofed in diftilled water. When heated till it ceafes to
exhale the fmell of vinegar, it then leaves a yellowifh
oxide, fubject to the attraction of the loadftone. The
acetous folution of iron affords with nut-gall, a very
black ink, and might be very advantageofly employed in
dyeing. Alkaline Pruffiates precipitate from it a very
bright Pruffian blue. Black, yellow, and brown oxide of
iron, and native carbonate of iron, or *fpathofe iron ore*, afford, with vinegar, folutions of a very beautiful red colour.

Copper is very eafily diffolved in the acetous acid.
This folution, with the help of heat, takes, by degrees,
a green colour. But the acid acts more readily on this
metal, when it has been already oxidated by vinegar,
and fo converted into the fubftance called *verdigris*.
Verdigris is prepared in the neighbourhood of Montpellier, by laying plates of copper into earthen veffels, in
layers covered with the hufks of grapes, previoufly fprinkled
and fermented with weak vinegar. The furfaces of
thefe plates are foon covered with a green ruft ; which is
increafed by piling them upon each other, and fprinkling
them with weak vinegar. The copper is then fcraped,
and the verdigris put up in leather bags for fale. M.
Montet, an apothecary at Montpellier, has given a very'
good defcription of this procefs in two memoirs printed
among the Memoirs of the Academy of Sciences, in the
years 1750 and 1753. Verdigris readily diffolves in vinegar. This folution is of a beautiful green colour, and
affords, by evaporation and cooling, green cryftals in
truncated quadrangular pyramids, which are called *cryftals of Venus*. The cryftals prepared for commerce,
which are called *diftilled verdigris*, on account of their
being prepared with diftilled vinegar, are in the form of
fine

fine pyramids. Thefe cryftals take a pyramidal form, from their being depofited on a piece of wood fplit into four branches, which are kept feparate by a piece of cork.

Acetite of copper has a very ftrong tafte, and is a violent poifon. It is decompofed by the action of fire. It effervefces in the air, and is covered over with a duft, the colour of which is a much paler green than the colour of the original falt. It is entirely diffolved in water, but not decompofed. Lime-water and alkalis precipitate this folution.

When this falt is reduced to powder, and diftilled in a glafs or earthen retort, with a receiver, it affords a fluid, which is at firft white and fomewhat acid, but foon becomes fo ftrong as to be not inferior in acidity to concentrated mineral acids. The receiver is changed, in order that the phlegm and the acid may be obtained feparate. The acid has been called *radical vinegar*, or *vinegar of Venus*. It is of a green colour, which it owes to a certain quantity of calx of copper that is carried up with it in the diftillation. When the diftillation ceafes, and the retort is red-hot, the refidue remaining is a brown copper-coloured duft, which frequently communicates a metallic tinge to the fides of the veffel. This refidue, as has been obferved by the Duke d'Ayen, and M. Prouft, is ftrongly pyrophoric. *Vinegar of Venus* is rectified by diftillation with a moderate heat. It is then perfectly white, provided it be not too much urged with fire towards the end of the operation, fo as to reduce the oxide of copper, remaining in the retort, to too dry a ftate. The reduction of copper which may be obferved in this operation, contributes to explain the nature of *radical vinegar*. This acid appears to bear the fame relation to common vinegar, which the oxigenated muri-

atic acid bears to the pure muriatic acid :—or rather, the same which the sulphuric bears to the sulphureous acid, or the nitric to the nitrous acid. In this operation, the acetous acid combines with the oxigene of the oxide of copper, which passes, at the same time, into a metallic state. The effects in the production, of which *radical vinegar* differs essentially from common vinegar, seem to be owing to the oxigene which that acid acquires. For this reason, we give it, according to the rules of the nomenclature now adopted through this work, the name of the *acetic acid.*

The acetic acid, or radical vinegar, rectified in this manner, is of so lively and pungent a smell, that it can scarce be borne. Such is its causticity, that when applied to the skin, it corrodes and cauterizes it : it is extremely volatile and inflammable : when heated in contact with air, it takes fire, and burns with more or less rapidity, according as it is more or less rectified. This fact has led chemists to think, that vinegar contains alcohol, and is a sort of natural æther. The poignant, agreeable smell which the first portions of this acid diffuse, favours the same opinion.

Acetic acid evaporates all away in the air. It combines with water, with a considerable heat : with earths, alkalis, and minerals it forms salts different from those into which common vinegar enters ; we call them *acetates* of potash, soda, zink, mercury, &c. M. de Laffone has shewn, that the ammoniacal salt formed by radical vinegar, or the acetic acid, is not of the same nature with ammoniacal acetite, or spirit of Mendererus. Although we are not yet sufficiently acquainted with all these acetates ; yet their form, taste, and solubility, shew plainly, that they are of a different nature from acetites.

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The Marquis dé Courtanvaux has fhown, that nothing but the laft portion of the acetic acid, obtained by the diftillation of acetite of copper or *verdigris*, is fufceptible of inflammation, and that it poffeffes likewife the property of being liable to congellation by cold. This laft portion, rectified, cryftallized in the receiver, in large plates, and in needles; nor did it become fluid, till it was expofed to a heat thirteen or fourteen degrees above the freezing point. In this property, this fubftance refembles the oxigenated muriatic acid.

The acetic acid decompofes alcohol, and forms æther as readily as mineral acids, as has been difcovered by the Count de Lauraguais. All that is neceffary to produce this effect, is to pour a quantity of radical vinegar upon an equal quantity of alcohol. A confiderable heat is excited. The retort is placed upon a hot fand-bath; and two receivers are adapted to it, the moft diftant of which communicates with a quantity of cold water, or pounded ice. This mixture muft be quickly boiled. There arifes from it, firft, a dephlegmated alcohol; after that, æther; and then an acid, which becomes gradually ftronger, as the procefs advances. In the retort there remains a brown mafs much like a refin. Care muft be taken to change the receiver affoon as the fmell of the æther becomes acrid and pungent, and to collect the acid by itfelf. The acetic æther, thus obtained, muft be rectified by a moderate heat with potafh. In this operation there is a good deal of it loft. The fermentation of this æther is owing to radical vinegar's containing an excefs of oxigene. Scheele relates, that he never fucceeded in preparing acetic æther from radical vinegar combined with alcohol, and could not accomplifh this preparation without adding a mineral acid. M. Pærner had already made the fame remark on the difficulty of obtaining ace-

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tic æther by M. de Lauraguais' procefs.   A great many
French chemifts have, however, employed this procefs;
and I myfelf, among others, with fufficient fuccefs.

M. de La Planche, apothecary, prepares acetic æther
by pouring concentrated fulphuric acid and alcohol upon
acetite of lead introduced into a retort.   The theory and
practice of this operation differ, in no refpect, from thofe
of the analogous procefs by which nitric and muriatic
æther are prepared. Acetic æther has, like every other fort
of æther, an agreeable fmell, which, however, is always
mixed with the fmell of vinegar, though not acid.   It is
very volatile and inflammable, burns with a lively flame,
and leaves, after its combuftion, a carbonaceous mark.

Chemifts need to make yet many more refearches into
the nature of the acetic acid.   What we have here faid
concerning its properties, will ferve to fhew, 1. That it
differs in a fingular manner from the acetous acid or com-
mon vinegar.   2. That the difference is owing to the
acetic acid's containing more oxigene than the acetous;
which excefs it has derived from the oxide of copper.—
Let us now refume the examination of the other proper-
ties of common vinegar.

The acetous acid, with the help of heat, diffolves the
gold precipitated by fixed alkali, from the oxigenated mu-
riatic acid.   This acetous folution of gold, precipitated
by ammoniac, affords *fulminating gold*, as has been fhown
by Bergman.   It acts in the fame way on platina and
filver.   While thefe metals are in a metallic ftate, vine-
gar is incapable of acting upon them; but it diffolves
them, when expofed to it in the ftate of oxides.

Vinegar is capable of combining with many of the
immediate principles of vegetables: It diffolves extracts,
mucilages, and effential falts.   It combines with the aro-
ma: It is thought to be the proper folvent for gum re-
fins.

fins. It has even, at length, or by the way of diftilla-
tion, a difcernible influence on fat oils, and reduces them
to a fort of faponaceous ftate. The combinations of vi-
negar with vegetable fubftances, have not been farther
examined with any accuracy.

This acid is ufed in the extraction of feveral of the
principles of vegetables, efpecially in the extraction of
their odoriferous principle; and various forts of vinegar,
both fimple and compound, are prepared for medical
ufes. Vinegar of fquills, colchicum, &c. afford inftances
of the fimple; theriacal vinegar, and the vinegar of the
four thieves, are compounds. Thefe medicines are pre-
pared by maceration and digeftion, continued for feveral
days. As this acid is volatile, it is diftilled on aromatic
plants, whofe odoriferous principle it takes up. Of this
kind is the diftilled vinegar of lavender, which is ufed at
the toilet. Thefe liquors are, in general, not fo agree-
able as fpiritous diftilled waters.

Vinegar is very much ufed as an article of feafoning.
It is much ufed in medicine, as being cooling and anti-
feptic : There is a fyrup made up of fugar and vinegar,
which is adminiftered with fuccefs in burning and putrid
fevers, &c. This acid, applied externally, is aftringent and
refolvent. All its combinations are, in like manner, ufed
as excellent medicines.

Acetite of potafh, and acetite of foda, which are
known by the names of *terra foliata tartari*, and *acetous
mineral falt*, are powerfully difcuffive and aperient : They
are given in dofes of half a drachm, or even a drachm
each.

Spirit of Mendererus, or ammoniacal acetite, given in
dofes of a few drops, in certain drinks, is aperient, diu-
retic, cordial, antifeptic, &c. It is often fuccefsful in

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the leucophlegmatia, or fwelling of the external parts of the body.

Acetite of mercury, or *terra foliata tartari*, is an excellent anti-venereal : it is the principal ingredient in Keyfer's pills.

The *extract of Saturn, vinegar of Saturn,* and *vegeto-mineral* water, are applied externally, as deficcatives. They are violently repercuffive, and ought therefore to be very cautioufly adminiftered, efpecially when applied to excoriated or ulcerated parts. Boerhaave mentions feveral young women who were attacked with confumptions, in confequence of the external ufe of preparations of lead.

Cerufe enters into the compofition of deficcative unguents and plafters ; and *verdigris* into feveral collyria and unguents.

The acetic acid, or *radical vinegar,* is given as a very active, irritating, and ftimulating medicine. It is held to the noftrils of perfons in fainting fits. In order that it may be the more conveniently made ufe of, a certain quantity of this acid is poured on fulphate of potafh in a coarfe powder, and put into a clofe-ftopped phial. This medicine is well known in the world, under the name of *falt of vinegar.*

Acetic æther has not yet been applied to ufe ; and it is not known whether it poffeffes any virtues different from thofe of the other forts of æther.

C H A P.

C H A P. XXV.

Of the Putrid Fermentation of Vegetables.

ALL vegetable fubftances that have fuffered the fpi-
ritous and the acid fermentation, are ftill liable to
undergo another inteftine motion, which is called *putrid
fermentation.* Stahl and feveral other chemifts think
this fermentation to be nothing but a confequential part
of the two other fermentations already defcribed ;—or ra-
ther, that the phænomena of all the three arife from
one internal emotion, the tendency of which is to deftroy
the texture of the folids, and to alter the nature of the
fluids. It is, in fact, obfervable, that certain vegetable
fubftances pafs, of themfelves, through three fucceffive
fermentations. For inftance, all faccharine matters, di-
luted in a certain quantity of water, and expofed to a
heat of—from 60 to 80 degrees, afford, firft wine, then
vinegar, and at laft lofe entirely their character of acidi-
ty : they are altered, become putrid, lofe all their vola-
tile principles, and are in the end reduced to a dry, in-
fipid, earthy fubftance. It is to be obferved, however,
that a great number of vegetable fubftances are not, in any
fenfible manner, liable to pafs fucceffively through thefe

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three forts of fermentation, in the above mentioned order.
Infipid mucilages and gums diffolved in water pafs into
an acid, without becoming difcernibly fpiritous: the
glutinous matter again feems to pafs, all at once, into a
ftate of putrefaction, without becoming acid. It ap-
pears, then, that although in feveral of the principles of
vegetables, thefe three fermentations follow each other
in regular fucceffion, yet many of thofe principles are fuf-
ceptible of the two latter fpecies of fermentation, without
having previoufly undergone the former; nay, are even
liable to putrefaction, without becoming previoufly acid.
Thofe of the laft mentioned character partake of the na-
ture of animal fubftances, and accordingly afford ammo-
niac by the action of fire, and azotic gas by the acid of
nitre. It is in confequence of their poffeffing fuch cha-
racteriftics, that thefe vegeto-animal fubftances putrefy
fo readily.

Certain conditions, well worthy of our attention, are
requifite, in order that the inteftine motion which chan-
ges the nature of vegetable matters, and reduces them
to their elementary principles, may take place. Humi-
dity, or the prefence of water, is one of the moft indif-
penfible of thefe conditions. Dry, folid vegetables, fuch
as wood, fuffer no alteration while they continue in that
ftate; but when their fibres are feparated by moifture,
an inteftine motion then commences. Water appears,
therefore, to be one of the caufes of putrefaction. And
when we come to examine the animal kingdom, we will
have occafion to fee, that the inteftine motion which
produces putrefaction begins with the decompofition of
that liquid. Heat is not lefs neceffary to putrefaction.
Cold, or the temperature of ice, is not only adverfe to
this fpontaneous deftruction in fubftances which have not
yet begun to fuffer from it; but even retards its pro-
grefs,

grefs, and, in fome meafure, reverfes it where it has already begun to operate. The degree of heat neceffary to putrefaction, is much inferior to what is required for the fpiritous and the acid fermentation ; for putrefaction takes place at the temperature of 45 degrees ; but a more confiderable heat is ftill more favourable ; at leaft, if it be not fo violent as to volatilize all the moifture of the putrefcent fubftance, and render it entirely dry. Accefs of air is another condition, fingularly favourable to putrefaction ; for vegetable fubftances are very well preferved *in vacuo.* The contact of air, however, is not fo indifpenfibly neceffary to putrefaction as the two other conditions already mentioned ; for this phænomenon fometimes takes place without its affiftance.

The putrefaction of vegetables exhibits peculiar phænomena. Vegetable fluids, when they putrefy, become turbid, lofe their colour, and depofite various fediments: bubbles afcend to the furface, and mouldinefs gathers over it in the beginning of the alteration. Soft vegetable matters exhibit the fame phænomena, on being fimply wet. The emotion then produced is at no time fo confiderable as that which appears in the cafes of fpiritous and acetous fermentation. The putrefying body does not appear to increafe in bulk, nor does its temperature become higher. But the principal phænomenon of putrefaction is, change of fmell, with the volatilization of an urinous, pungent, acrid principle,—in a word, ammoniac. From this circumftance, putrefaction has been called alkaline fermentation, and ammoniac confidered as its product. The pungent fmell exhales by degrees, and is fucceeded by a naufeous, infipid fmell, which can fcarce be defcribed. The decompofition has now attained its height: The putrid, vegetable mafs, is become very foft, like a jelly ; it finks down, and the odorous principle exhaling from it fuffers a great many fucceffive modifications.

tions. At laft it becomes dry, and lofes, by degrees, its difagreeable fmell ; and what remains is nothing but a blackifh, and feemingly carbonaceous refidue, known by the name of *humus vegetabilis*, which is found to contain nothing but faline and earthy fubftances. Such is the order of the phænomena that are fucceffively obferved in the fpontaneous decompofition of putrefying vegetables. But this procefs of decompofition, when carried fo far as to reduce the vegetable body to an earthy or faline refidue, is extremely tedious, and, we may even add, has never yet been obferved by any perfon with fuitable attention. Chemifts and naturalifts have paid ftill lefs attention to the putrefaction of vegetable, than to that of animal fubftances. No philofopher has hitherto undertaken to obferve all the phænomena of the putrefaction of vegetables, but many have begun to defcribe thofe which attend the putrefaction of animal matters. Here, therefore, it appears proper for us to conclude our hiftory of the fpontaneous and natural decompofition of vegetables with the following obfervations : 1. The little which we have here faid concerning it, is fufficient to fhow, that the putrefaction of vegetables attenuates, volatilizes, and deftroys all their humours, and reduces them to an earthy ftate : 2. We have as yet no certain knowledge of the phænomena and the limits of this fpecies of putrefaction, which is to be carefully diftinguifhed from the putrefaction of animal matters : 3. Laftly, as this fermentation is much more confpicuous, and has been much more attentively obferved in the humours and folids of animals; the more extenfive detail of particulars which we are to give, in our account of animal fubftances, will complete the fketch which we have here marked out, and conclude the hiftory of thofe facts that are known concerning putrefaction.

PART FOURTH.

The ANIMAL KINGDOM,

CHAP. I.

Of the Chemical Analysis of Animal Substances in general (1).

IN the analysis of animal substances, we meet with greater difficulties than in any other part of chemistry; and our chemical knowledge of those substances is accordingly in a more imperfect state than any other branch of the science. The ancient chemists were content with distilling them by naked fire; an operation which is at present known to alter and totally destroy the nature of such compound bodies as the solids or fluids of animals. The only parts of animals that have yet been subjected to an analysis, are, some of the humours

(1) In the second edition of this Work, the animal kingdom began with a brief account of the nature of animals, the distinctions subsisting among them, the methods requisite for marking out those distinctions in Natural History and the Natural Philosophy of Animals. The mode of arrangement now adopted in these volumes, and the little connection between the natural description of animals, and the chemistry of animal matters, have induced me to remove that part into a fifth volume. A.

mours of the human body, and the humours of certain quadrupeds.

Many circumſtances have concurred to retard the progreſs of this branch of chemiſtry. The difficulties with which reſearches of this kind were attended, and the contradictory reſults which they often afforded; the imperfection of the chemical methods with which, till within theſe few years, animal matters were always treated, and which conſtantly produced on them great alterations ; the impoſſibility which was always found of approaching near to a reproduction of any animal matter by ſyntheſis ; and, above all, the ſmallneſs of the inducements which any but medical chemiſts could have to engage in ſuch reſearches, are the principal reaſons which have prevented the enlargement of this department of the ſcience of chemiſtry. But the reſearches of ſeveral moderns, eſpecially of Meſſrs Rouelle, Macquer, Bucquet, Pouiletier de la Salle, Berthollet, Prouſt, Scheele, and Bergman, have here opened a new tract of diſcovery, and ſhew, that the art of healing may derive the moſt ſignal advantages from reſearches of this kind.

The human body, and the bodies of quadrupeds—the principal animals which engage our attention—are compoſed of fluids and ſolids. The humours of animals are divided into three claſſes, according to the purpoſes for which they ſerve. The firſt contains the recrementitial humours, the uſe of which is to nouriſh certain organs : the ſecond comprehends the excrementitial humours, which are evacuated by certain emunctories, as uſeleſs, and even noxious, when retained too long within the body : the third claſs conſiſts of humours to which the characteriſtics of both the two former claſſes belong, they being partly recrementitial, and partly excrementitial. To the firſt claſs belong the blood, the lymph,

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the jelly or gelatinous part, the fibrous or glutinous part, the fat, the marrow, the matter which fupports interior perfpiration, and the offeous juice. The fecond clafs confifts of the fluid which is infenfibly tranfpired by the pores, the fweat, the mucus of the noftrils, the cerumen of the ears, the gummy matter of the eyes, the urine, and the fæces. Thofe of the third clafs are, the faliva, the tears, the bile, the pancreatic juice, the gaftric and inteftinal juices, the milk, and the feminal liquor. We cannot examine all thefe fluids in the order in which they are here mentioned; 1. Becaufe they are ftill but very little known: 2. Becaufe it is abfolutely neceffary that we treat firft of fuch as have been the moft completely analyfed.

The folids of animals, which form the parenchyma of their different organs, may be divided into three claffes. In the firft of thefe claffes I rank the foft white parts, fuch as the laminæ of the cellular tiffue, the membranes, the membranous vifcera, the aponeurofes, the ligaments, the tendons, and the fkin. The foft red parts form a fecond clafs very different from the former; fuch are, particularly, the mufcles, and a part of the organs which contain the mufcular fibres, as the ftomach, the inteftines, the bladder, the matrix, &c. Laftly, the third clafs comprehends the offeous or bony folids.

Animal matters are at prefent analyfed in a very different way from that in which they were analyfed a few years fince. They are no longer fubjeĉted to decompofition by fire; they are now treated by reagents, particularly acids, alkalis, alcohol, &c. The different fluids intermingled with each other, or contained in the veficles of the different parts, are feparated by reft, decantation, filtration, or expreffion. The action of thefe fubftances on colouring matters is examined, and the feveral

changes

changes which they are liable to suffer in different tem-
peratures are observed.   Animal liquors are carefully
evaporated, and the different salts which they contain,
extracted from them unaltered.

By these methods of analysis, modern chemists have
made a number of important discoveries concerning ani-
mal substances.   Scheele has found them to contain se-
veral acids different from those which were before
known.   M. Berthollet has demonstrated the existence
of phosphoric acid, in a naked state, in urine and sweat;
and has likewise found, in animal matters, a remark-
able quantity of the azotic principle.   This last discovery
is one of the most important facts which the analysis of
animal matters has made known to us.   The existence
of azote in these substances, especially in their fibrous
parts, accounts for the difference between animal and
vegetable matters.   This body is obtained in the state
of elastic fluidity, or in azotic gas, by treating the flesh
of the muscles with nitric acid : even without the ope-
ration of any external heat, it is disengaged in a pretty
large proportion; it passes before the nitrous gas, and
when the nitrous gas begins to be disengaged, the ope-
ration should be stopped, and the vessels changed.

M. Berthollet explains, by this discovery, the forma-
tion of the ammoniac which animal substances afford
when treated with fire,—the production and disen-
gagement of that salt by putrefaction,—and the re-
lation between these substances, and vegetable mat-
ters that are liable to putrefaction, and afford ammoniac
by distillation.   It appears, in fact, that in both these
instances, the ammoniac is formed by the combina-
tion of hydrogene with azote.   I believe I cannot here
do better than give, in M. Berthollet's own words,
<div align="right">what</div>

what he has said concerning the nature of animal sub-
stances in general, in a Memoir read before the Faculty
of Medicine, and inserted in the *Journal de Physique*,
vol. 28. page 272.

" Organized bodies are chiefly composed of two sub-
" stances, which are distinguished from each other by
" very eminent peculiar characteristics. Of these sub-
" stances, one class affords acids, when decomposed by
" the action of fire; the other *volatile alkali*: The
" one class forms *ardent spirit* by fermentation; the
" other immediately putrefies, still affording *volatile alkali*:
" The one leaves, when calcined, a coal that burns easi-
" ly; the other is reduced to a coal which burns with
" difficulty: The one, in short, forms the greater part
" of vegetable, the other of animal substances; and
" hence they are distinguished by these two different de-
" nominations.

" M. Bergman, by means of sugar and the *nitrous*
" acid, produced an acid which he called the *saccharine*
" *acid*, possessing peculiar and remarkable properties.
" On applying to animal substances this analysis by *nitrous*
" acid, I found that they all afforded more or less *sac-*
" *charine* acid, which was always accompanied with a pe-
" culiar oil. I observed, that no ammoniacal salt was ob-
" tained, but a residue remained, which vegetable sub-
" stances do not afford. From these first experiments, I
" concluded, in the *Memoirs of the Academy for the year*
" 1780, that animal matters contained some substance a-
" nalogous to sugar, in combination with an oil which I
" considered as peculiar to animal matters. I learned far-
" ther, from my experiments, that *volatile alkali* did not
" exist in animal substances, but was produced by some
" combination, effected either by the action of heat, or

" by

" by the influence of putrefaction.   And laftly, the re-
" fidue, concerning which I did not explain my fenti-
" ments in that Memoir, contains an excefs of phofpho-
" ric acid, combined with calcareous earth.

    " I afterwards examined the action of metallic *calces*
" and falts on animal fubftances, and proved, that the
" action to which thefe owed their caufticity was a con-
" fequence of the chemical affinities by which metallic
" *calces* tended, with more or lefs force, to revivifica-
" tion ; the *calces* of filver and mercury, which are very
" eafily reduced, having an high degree of caufticity,
" and forming very cauftic falts.   It follows, on apply-
" ing the late difcoveries of natural philofophers to the
" theory which I have given, that it is the air, exifting
" in a combined ftate in metallic *calces*, and without its
" principle of elafticity, which tends to unite with fome
" principle in animal fubftances ; which principle appears
" to me to be the oil which they contain.   But the cau-
" fticity of alkalis cannot be afcribed to the fame caufe;
" it muft be owing to fome other affinity.   In the Me-
" moirs of the Academy for the year 1782, I have prov-
" ed that cauftic alkali diffolves animal fubftances, without
" dividing their principles.   I have explained the proper-
" ties of this combination, and afterwards employed it in
" uniting animal fubftances with the different metallic
" *calces*.   Several combinations, not previoufly known to
" chemifts, were produced : But cauftic alkali, treated in
" the fame way with vegetable fubftances, formed no
" combination with them.

    " Purfuing my refearches, I have at length difcover-
" ed the principles of *volatile alkali*.   I have fhown *vo-*
" *latile alkali* to be a combination of detonating *inflam-*
" *mable gas*, or, more accurately, of the inflammable gas
                                                      " of

" of water with *phlogifticated* or *mephitic* air, in fuch
" proportions, that inflammable gas compofes one-fixth
" of the weight, or two-thirds of the bulk of *volatile*
" *alkali.* I next afcertained in what manner *volatile al-*
" *kali* may be produced by putrefaction, or the action of
" fire. All fubftances poffeffing the characteriftics of
" animal fubftances, contain *mephitis*, which may be fe-
" parated from them in abundance, by the operation of
" the *nitrous* acid. When thofe fubftances are diftilled,
" therefore, their *mephitis* muft, of neceffity, either pafs
" into fome new combination, or be found among their
" aeriform products. But among thefe laft it is never
" found; as I fully afcertained by detonizing *inflammable*
" *gas*, obtained by this means, in M. Volta's eudiome-
" ter, and comparing it with inflammable gas obtained
" by diftillation from charcoal, and with that of vegetable
" fubftances; and, after the *inflammable gas*, there is
" none other but the *volatile alkali* among the products
" obtained by diftillation from animal fubftances, into
" the compofition of which the mephitis can poffibly be
" received. Confequently, whenever *volatile alkali* is
" formed, the *mephitis* of the animal fubftances combines
" with the *inflammable gas* feparated from the oil, or
" more probably with that produced by the decompofi-
" tion of the water, whofe vital air combines at the fame
" time with charcoal, to form *fixed air* ; in putrefaction,
" the *inflammable gas* combines with the *mephitis* ; where-
" as, in the fpiritous fermentation, the fame gas combines
" with a vegetable oil and fugar to form *fpirit of wine,*
" in which I have difcovered and feparated thefe fub-
" ftances by means of the *dephlogifticated marine acid.*
" From thefe feveral obfervations, it follows, that
" animal fubftances are of a much more compound na-
" ture than fubftances purely vegetable. They contain

" a matter analogous to ſugar, a peculiar oil, phoſphoric
" acid combined with calcareous earth, *mephitis*, and very
" probably *fixed air*. It is the phoſphoric acid which
" exiſts in the coal of animal ſubſtances, in combination
" with a portion of real charcoal, oil and earth, that ap-
" pears to me to occaſion the difference obſerved between
" the coals of animal and thoſe of vegetable ſubſtances."

Such is the accuracy and perſpicuity with which M.
Berthollet explains the nature of animal ſubſtances in ge-
neral.   When theſe diſtinct facts and fair deductions are
compared with the vague notions which before prevailed
concerning the difference between animal and vegetable
matters, the progreſs which chemiſtry has made within
theſe few years, by means of the reſearches of Swediſh
and French chemiſts, cannot but appear aſtoniſhing. There
is the ſtrongeſt reaſon to hope, that farther experiments
on animal matters, upon the ſame plan which has been
marked out and purſued by the moſt celebrated chemiſts,
from Margraf and Rouelle to the preſent inſtant, will
ſupply a great deal of valuable information concerning
theſe ſubſtances; their formation, the alterations which
they are liable to undergo, and their deſtruction; and
particularly, may be of the moſt eſſential ſervice to the
ſcience of Medicine.   The truth of this aſſertion will be
fully proved, by the account of the diſcoveries already
made, and of their application, which we are to exhibit
in the following chapters.

C H A P.

C H A P. II.

Of the Blood.

THE moft important, the moft compound, and the moft impenetrable of the recrementitial humours, is the blood. We treat of it firft, becaufe the greateft phyficians maintain it to be the fource and centre of all the other animal fluids. Many phyficians, efpecially M. Bordeu, have confidered it as a fort of running flefh, a compound of all the animal humours: an opinion, which, though highly probable, has not been yet fully demon- ftrated.

The blood is a fluid of a beautiful red colour, of a fat, unctuous, and, as it were, a faponaceous confiften- cy; of a tafte fomewhat faline, but almoft infipid; and contained in the heart, artéries, and véins. This fluid is differently modified by the different parts through which it flows: For inftance, in the arteries and veins, in the breaft and the region of the liver, in the mufcles and the glands, &c. it is not the fame. This fact has not fufficiently engaged the attention of chemifts.

In confidering the blood as it exifts through the whole animal kingdom, we obferve, that in different

animals

animals it is fingularly diverfified in colour, confiftency, fmell, and efpecially temperature. The laft is the moft important of all thefe properties, and feems to depend on the circulation and the refpiration. The human blood, and that of quadrupeds and birds, is hotter than the medium which they inhabit; and, for this reafon, thefe are called *hot-blooded animals*. The blood of fifhes and reptiles, again, is nearly of the fame temperature with the medium which they inhabit; and thefe are, for this reafon, called *cold-blooded animals*. Other properties of this fluid, efpecially its chemical qualities or characteriftics, would probably be found, if we were acquainted with the blood of all animals, to be fubject to the fame variations.

The human blood, which more efpecially engages our attention, is differently modified by the age, the fex, the temperament and the ftate of the health of each individual. In infants, the female fex, and confumptive perfons, it is paler and thinner. In robuft and healthy perfons, it is thick, of a deep red colour, almoft black, and of a much more faline tafte than in the former.

Before proceeding to an analyfis of the blood, it is neceffary that we get acquainted with its phyfical properties—its colour, heat, tafte, fmell, and peculiar confiftency—of which we have already taken notice. By the microfcope we difcover in it a great many globules, which, according to Lieuwenhoek and Boerhaave, when broken in circulating through the fmaller paffages, lofe their red colour, and become firft yellow, and then white; fo that, according to the phyfician of Leyden, a red globule is an affemblage of other fmaller white globules, and owes its colour to its aggregation. There is another fingular property belonging to the blood. While hot and in motion, it continues fluid and red:

When

When cooled and at reft, it becomes a folid mafs, which, by degrees, feparates into two parts; the one red and fupernatant, its colour dark, and its confiftency concrete, till fuch time as it fuffer an alteration;—this is called the clot of the blood: the other occupies the bottom of the veffel, and is of a greenifh yellow colour, and adhefive;—it is called the ferum or lymph. This fpontaneous coagulation and feparation of the two parts of the blood takes place in the laft moments of an animal's life; and produces thofe concrete matters which are found in the heart, and the larger veffels of deceafed animals, and have been miftaken for polypi.

Blood, expofed to a gentle and continued heat, paffes into the ftate of putrid fermentation. When diftilled on a water-bath, it affords a phlegm of a faint fmell, which is neither acid nor alkaline, but eafily putrefies, in confequence of its containing an animal fubftance diffolved through it. Expofed to a more intenfe heat, blood, as has been difcovered by De Haen, gradually coagulates and becomes dry: it then lofes feven-eighths of its weight, and becomes capable of effervefcence with acids. By conducting the fire properly, it may be hardened into a fort of corneous fubftance. Deficcated blood, expofed to the open air, attracts from it fome degree of moifture, and, in the courfe of a few months, there is formed on it a faline efflorefcence, which Rouelle has determined to be carbonate of foda. When diftilled by naked fire, it affords a faline phlegm,—that is, a phlegm holding in folution an ammoniacal falt, fuperfaturated with ammoniac. The nature of the empyreumatic acid contained in this ammoniacal falt, which was firft obferved by Wieuffens, and has given rife to fo many difputes among phyfiologifts, has never yet been fufficiently examined. After this phlegm, a light oil paffes,—then a ponderous, coloured oil, and ammoniacal carbonate contaminated

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with

with a thick oil. There remains in the retort a fpungy coal, very difficult to be incinerated, which is found to contain muriate of foda, carbonate of foda, oxide of iron, and a matter apparently earthy, which feems to be calcareous phofphate.

Blood combined with alkalis, without previous decompofition, becomes more fluid by ftanding. Acids inftantaneoufly coagulate it, and alter its colour. By filtrating this fubftance, evaporating the liquor paffed through the filter, drying it before a moderate fire, and lixiviating the matter that has been dried, neutral falts are obtained, confifting of foda with the acid that was mixed with the blood. Alcohol coagulates blood.

Experiments made on blood in its original ftate, do not difcover the nature of the fubftances of which it confifts. But the fpontaneous decompofition of blood, and the feparation of its two component parts, the clot and the ferum, afford us an opportunity of acquiring that knowledge by examining each of thefe matters by itfelf. Till within thefe few years, the chemical analyfis of the blood was confined to what has been related in the foregoing pages ; but Meffrs Menghini, Rouelle the younger, and Bucquet have examined this fluid in a very different manner. The two laft of thefe chemifts efpecially have conducted their experiments on this matter in a way which fhews to what perfection the analyfis of animal matters may be carried, by proceeding on their plan. The following account of the properties of the feveral fubftances which compofe the blood, is derived from the difcoveries of thofe philofophers.

The ferum is very far from being pure water, but a peculiar matter, highly worthy of examination, to which we give the name of the *albuminous fluid.* It is of a yellowifh white colour, fomewhat inclining to green ; its

tafte

taſte is ſaltiſh, but nearly inſipid ; its conſiſtency unctuous and adheſive. When expoſed to the action of fire, it coagulates and becomes hard, long before it can be heated to ebullition : it communicates a green tinge to ſyrup of violets. By diſtillation on a water-bath, it affords a phlegm of a mild, inſipid taſte, which is neither acid nor alkaline, but ſpeedily putrefies. After loſing this phlegm, it is dry, hard, and tranſparent like horn : it is no longer ſoluble in water : by diſtillation in a retort, it affords an alkaline phlegm, a conſiderable quantity of ammoniacal carbonate, and a very fœtid, thick oil. All theſe products, in general, have a peculiar fœtid ſmell. The coal of the ſerum, when diſtilled by naked fire, almoſt entirely fills the retort. It is ſo difficult to incinerate, that it muſt be kept burning for ſeveral hours, and expoſed to a great deal of freſh air before it can be reduced to aſhes. The aſhes are of a blackiſh grey colour, and contain muriate and carbonate of ſoda, with calcareous phoſphate.

The ſerum, if expoſed for ſome time to an hot temperature, in an open veſſel, paſſes readily into a ſtate of putrefaction, and then affords a conſiderable quantity of ammoniacal carbonate, with an oil, the ſmell of which is inſufferably nauſeous. It putrefies ſo ſpeedily, that Bucquet could not diſcover whether it paſſed into an acid ſtate before becoming alkaline. This liquor combines with water in any proportion ; and then it loſes its conſiſtency, its taſte, and its greeniſh colour. To promote the combination, the mixture needs to be ſhaken ; becauſe the difference between the denſities of the two fluids obſtructs their union. The ſerum, when poured into boiling water, coagulates almoſt wholly and inſtantaneouſly. A portion of that fluid forms, with the water, a ſort of opaque and milky white liquor ; which,

according

according to Bucquet, poffeffes all the chara&eriftic
properties of milk ; that is, is rarefied and caufed to
mount up, like that fluid, by heat, and is coagulated
by the fame agents—by acids, and by alcohol.

Alkalis render the ferum more fluid by effe&ing a fort
of folution of it.   Acids alter it in a different manner,
increafing its confiftency, and coagulating it.   This mix-
ture, filtrated and evaporated after filtration, affords a
neutral falt formed of foda and the acid employed : And
this fa& proves foda to exift in the ferum in a naked
ftate, in full poffeffion of all its properties.   The coa-
gulum formed in this liquor by the addition of an acid,
is very fpeedily diffolved in ammoniac, which is the ge-
nuine folvent of the albuminous part of the blood ; but
it does not diffolve at all in pure water.   Acids precipi-
tate this matter in union with ammoniac.   The coagu-
lum, diftilled by naked fire, affords the fame produ&s
as the ferum deficcated ; and its carbonaceous refidue
contains a good deal of carbonate of foda ;—a circum-
ftance which, in Bucquet's opinion, fhews, that there
exifts a portion of that falt in a ftate of intimate com-
bination, in the ferum, which the acid employed to co-
agulate it does not faturate.

The ferum, infpiffated, affords azotic gas by the
a&ion of the nitric acid, with the help of a moderate
heat.   On increafing the fire, there is a quantity of
nitrous gas difengaged from the mixture : the refidue
affords oxalic acid, and even a fmall quantity of malic
acid.

The ferum does not decompofe calcareous or alumi-
nous neutral falts ; but it a&s with fufficient energy in
decompofing metallic falts.   It is liable to be coa-
gulated by alcohol : this coagulum differs confider-
ably from that formed in the ferum by acids, chiefly
in

in its folubility in water, as Bucquet has difcovered. This liquid appears, therefore, from thefe refearches, to be an animal mucilage, confifting of water, acidifiable oily bafes, muriate and carbonate of foda, with calcareous phofphate : The rofe-coloured precipitate which I have obtained by pouring a portion of a nitric folution of mercury into the ferum, appears to be owing to the latter of thefe principles. Although this liquid has fcarce any colour, yet nitric acid, and, ftill more, nitrate of mercury, produces, when poured into it, a rofe or light flefh-colour, which I have had occafion to obferve in many other animal liquors. The moft fingular property of this mucilage,—a property highly worthy of engaging the attention of phyficians,—is, its being liable to become concrete by the action of fire and acids. Scheele thought this phenomenon owing to the combination of heat.

The clot of the blood affords, by expofure to the heat of a water-bath, an infipid water ; it becomes, at the fame time, dry and brittle. It affords, in the retort, an alkaline phlegm, a thick oil, of a fœtid, empyreumatic fmell, and a good deal of ammoniacal carbonate. The refidue which it leaves, is a fpongy coal, of a fparkling metallic afpect, difficult to incinerate, and affording, when treated with fulphuric acid, fulphate of foda and fulphate of iron : there remains, after thefe operations, a mixture of calcareous phofphate with carbonaceous matter. Expofed to an hot atmofphere, the clot putrefies readily enough. When wafhed with water, that fluid feparates it into two very diftinct matters ; the one it diffolves deriving from it a red colour. The folution, treated with different menftrua, exhibits all the fame characteriftics with the ferum, but is found to contain much more iron. The metal is feparated by incineration,

incineration, and by wafhing the incinerated coal, in order to carry off the faline matters. The remaining part of the lixivium, after the faline matters are carried off, is in the ftate of oxide of iron, of a brown colour, of confiderable beauty. It is ufually fubject to the attraction of the magnet. Blood is thought to owe its colour to this metal. A very confiderable proportion of iron has been extracted from this fluid by Meffrs Menghini, Rouelle, and Bucquet.

The clot, after being wafhed and cleared from all the red ferum which it contains, is in the ftate of a fibrous white matter; which it remains for us to examine.

The fibrous part of the blood is white and colourlefs, after being well wafhed: its tafte is infipid. It affords, by diftillation on a water-bath, an infipid phlegm, without fmell, and liable to putrefaction. Even the gentleft heat hardens this fibrous matter in a fingular manner. When expofed fuddenly to a ftrong fire, it fhrinks like parchment. By diftillation in a retort, it affords an ammoniacal phlegm, a ponderous oil, which is thick and very fœtid, and a good deal of ammoniacal carbonate, contaminated with a portion of oil. The refidual coal is not very bulky, but compact, ponderous, and eafier incinerated than that of the ferum. Its afhes are very white: it contains no faline matter, as it muft have loft, by the wafhing, whatever it contained of that kind,—and no iron: it is a fort of refidue of an earthy appearance, and feemingly calcareous phofphate.

The fibrous part of the blood putrefies very quickly and with great facility. When expofed to an hot, moift atmofphere, it fwells, and affords a good deal of ammoniac. It is not foluble in water: when boiled in that fluid, it becomes hard, and acquires a grey colour. Al-

kalis

kalis do not diffolve it; but even the weakeft acids combine with it: The nitric acid difengages from it a confiderable quantity of azotic gas, as we are told by M. Berthollet; and at length diffolves it with effervefcence and the difengagement of nitrous gas. When it ceafes to emit nitrous gas, the refidue is obferved to contain oily and faline flakes fwimming in a yellowifh liquor: This liquor affords, by evaporation, oxalic acid in cryftals; and, at the fame time, depofites no inconfiderable quantity of flakes, compofed of a peculiar oil and calcareous phofphate. It appears that there are in the fibrous part two oils; one of which conftitutes, in combination with oxigene, oxalic acid; while the other forms, with the fame principle, malic acid.

The fibrous matter diffolves alfo in the muriatic acid, which converts it into a fort of green jelly. The acid of vinegar diffolves it with the help of heat: Water, and efpecially alkalis, precipitate this fibrous matter from acids. This animal matter is decompofed in thefe combinations; and when feparated, by whatever means, from acids, no longer exhibits the fame properties. Neutral falts, and other mineral matters, are incapable of acting upon it. It unites with the albuminous matter, efpecially with that which is coloured, to form clot. This laft fubftance, as well as the fibrous part, is totally foluble in acids; on account, no doubt, of the combination of that matter with the red ferum. From this it appears, that the fibrous part differs greatly from the albuminous matter. It is more of an animal nature than that matter, being a fort of animal gluten, bearing no fmall refemblance to that of farina, and poffeffing the remarkable property of becoming concrete by reft and cooling. There is no doubt that this matter, which has not been fufficiently attended to by phyfiologifts and pathologifts,

thologifts, acts an important part in the animal œcono-
my. I have a confiderable time fince obferved, that
it is depofited in the mufcles, and conftitutes the fibrous
bafe of thofe organs, and that fubftance which is moft
eminently irritable. I have concluded this fubftance to
merit more attention than it has yet obtained, and have
confidered it as capable of occafioning, by its excefs or
deficiency, certain difeafes : And I have given my rea-
fons for entertaining fuch opinions, in a memoir which
is inferted among the Memoirs of the Royal Society of
Medicine for the year 1783, &c.   It appears that the
peculiar acid which the blood affords by diftillation, and
which M. Chauffier has obtained from it by the action
of alcohol, exifts in the fibrous part of its fubftance.
For this reafon, I have propofed to call it the *cruoric
acid,* if it fhould ever be determined to be a peculiar
animal acid.

  After all thefe ingenious difcoveries concerning the
nature of the blood, yet we are far from being fuffi-
ciently acquainted with all its chemical properties. We
are yet ignorant of the minute difference which fubfifts
between the ferum and the fibrous part. The blood
has not yet been examined in all its various ftates ; par-
ticularly in different difeafes, in which that fluid fuffers
confiderable alterations, fuch as violent inflammations,
the chlorofis, fcurvy, &c.   Phyficians diftinguifh thefe
alterations only by external appearances ; and it is
much to be wifhed that accurate analyfes fhould de-
termine their nature in fuch a manner as to afford a
better direction to the practitioner in the art of healing.

  Rouelle has examined the blood of various quadru-
peds, the ox, the horfe, the calf, the fheep, the hog,
the afs, and the goat.   He obtained from them the
fame products which the human blood affords, but in
different proportions.

                                        C H A P.

C H A P.   III.

Of the Milk.

THE milk is a recrementitial humour, defigned by nature for the nourifhment of the young of animals in the firft period of their exiftence. It is of a dead white colour, a mild faccharine tafte, and a fmell faintly aromatic. The female of the human fpecies, female quadrupeds, and cetaceous animals of the fame fpecies, are the only animals that afford milk. No other animal is furnifhed with organs for the fecretion of this humour. It was long thought, that the milk was immediately feparated by glands in the breafts, from the blood conveyed into them by the numerous arteries which meet there. But the principles of which milk is known to confift, have not been hitherto proved to exift in the blood; and late difcoveries in anatomy have fhewn, that the breafts are furnifhed with a great many lymphatic and abforbent veffels, difpofed in a greafy tiffue; and the liquor which thefe contain, is perhaps one of the chief conftituent principles of milk.

Milk is very different in different animals. In woman it is highly faccharine. Cow's milk is mild, and its principles are intimately united. The milk of the goat and the afs poffeffes peculiar virtues, and is often gently aftringent. The properties of milk are liable to vary, as they commonly depend on the nature of the food with which animals are nourifhed.

Cow's milk, which we may take as an inftance, as it is fo eafily procured, is a compound of three different fubftances; ferum or whey, which is fluid and tranfparent,— butter and cheefe, which have more confiftency. Thefe three parts are fo mixed and fufpended, as to form a fort of animal emulfion.

Milk, diftilled by the heat of a water-bath, affords an infipid, inodorous phlegm, fufceptible of putrefaction. Expofed to an heat fomewhat ftronger, it coagulates like blood, as has been obferved by Bucquet. When ftirred and evaporated flowly, it forms a fort of faccharine extract, known by the name of *franchipane.* This extract, diffolved in water, forms Hoffman's whey. Diftilled by naked fire, it affords acid, fluid oil, concrete oil, and ammoniacal carbonate. Its refidual coal contains a little potafh, muriate of potafh, and calcareous phofphate.

Milk, expofed to an hot temperature, is liable to pafs into a ftate of fpiritous fermentation, in which it forms a fort of wine; but a confiderable quantity of it muft be together, in order that this alteration may take place. The Tartars prepare a fpiritous liquor from mare's milk. The milk becomes quickly acid, and then coagulates. The cheefe gathers into a mafs, leaving the whey feparate.

Acids have inftantaneoufly the fame effect on milk. They coagulate it; this *coagulum* is again diffolved by alkalis, efpecially by ammoniac. Boerhaave afferts, that

milk

milk boiled with oil of tartar becomes firft yellow, and takes afterwards a blood-red colour. He is even of opinion, that it is by fome fuch combination milk is converted in the human body into the ftate of real blood. Neutral falts, fugar and gum likewife coagulate milk, with the help of heat ; as has been obferved by Scheele.

To make whey, milk muft be warmed with an addition of rennet, in the proportion of twelve or fifteen grains to the pint. This fubftance being a mixture of milk foured in the ftomachs of calves, with the gaftric juice, is a fermenting fubftance which coagulates the cafeous part. After this coagulation is effected, the whey is ftrained from the curds. *Gallium,* the flowers of thiftles, and artichokes act on milk in the fame way as rennet. The external membrane of the ftomachs of calves and birds, when dried and reduced to powder, produces the fame effect on milk : a fact which proves, that the coagulation of this liquor is owing to the dried gaftric juice contained in the pores of that membrane.

The ferum or whey prepared in this way, is turbid : it may be clarified with white of eggs and tartar. When the ferum or whey is wanted very pure, in order to be examined, no acidulous tartarite of potafh fhould be intermixed with it.

Whey has a mild tafte. When prepared from new milk, it contains a faccharine effential falt ; but it foon acquires a four tafte, in confequence of that fermentation which takes place in it. This emotion is produced by the alteration of a mucilaginous principle contained in milk ; and it is the extrication of this acid from a latent ftate which feparates the whey from the other principles of which milk confifts. It will therefore be proper to

examine

examine the nature of the acid which is formed in four milk, and conftitutes fermented whey.

It is well known, that milk left to itfelf at a temperature of feventy or eighty degrees, fuffers, in the fpace of a few days, a fermentation which developes an acid, and feparates the butter and cheefe. The acid which is formed by this fermentation, and acquires, in the fpace of twelve or fifteen days, all the ftrength of which it is capable, has been examined by Scheele : We call it the *lactic acid*. The following is the procefs by which Scheele obtained this acid pure, after attempting ineffectually to feparate it from four milk by diftillation. This operation having afforded him only a very fmall portion of acid, he evaporated four whey to an eighth part, after filtering it, to feparate all the cafeous matter. The animal earth he precipitated by lime-water. He diluted it with three times its weight of water ; and feparated the lime by oxalic acid. To afcertain whether any oxalic acid remained in it, he affayed it with lime water ; and then evaporated the liquor to the confiftency of honey ; and precipitated the fugar of milk, and fome other extraneous fubftances, by mixing with it alcohol, which eafily diffolves the lactic acid. Laftly, he diftilled this folution ; and after the alcohol was thus volatilized, the lactic acid remained pure in the retort. Scheele afcribes to this acid the following properties.

Evaporated even to a very thick confiftency, it affords no cryftals ; it attracts moifture from the atmofphere. By diftillation it affords an empyreumatic acid, refembling the pyro-tartareous acid, a little oil, and a mixture of carbonic acid gas, with carbonated hydrogenous gas.

In union with the three alkalis, with barytes, or with lime, the lactic acid forms deliquefcent falts. In combination

nation with magnefia, it forms cryftals; but thefe, too, attract moifture from the atmofphere. Moft of thefe falts of milk, or alkaline and earthy lactates, are foluble in alcohol. The acid of milk does not act, in any way, on cobalt, bifmuth, antimony, mercury, filver, or gold, even though affifted by a boiling heat. It diffolves zinc and iron, producing from them hydrogenous gas: the former of thefe falts, lactate of zinc, cryftallizes; the other, lactate of iron, forms a deliquefcent brown mafs.

The lactic acid oxidates and diffolves lead and copper. The lactic folution of lead depofites a little fulphate of lead; from which it appears, that this animal acid contains a fmall portion of fulphuric acid. Laftly, it decompofes acetite of potafh: This laft property, with the reft here mentioned as belonging to it, fhew the lactic acid to be different in its nature from vinegar. To thefe particulars, Scheele adds, that real vinegar may be obtained from milk, by mixing fix fpoonfuls of alcohol with three pints of milk, and leaving the mixture to ferment in a well-ftopped veffel: the gas difengaged by the fermentation of the mixture, muft be, from time to time, fuffered to efcape: at the end of a month, the milk is found changed into good vinegar: it may be then ftrained through a cloth, and put up in bottles. The celebrated Swedifh chemift adds farther, that milk in a bottle, the neck of which enters a veffel filled with the fame liquor, undergoes, if expofed, in this condition, to an heat fomewhat fuperior to the ordinary heat of fummer, a fermentation which occafions the difengagement of a large quantity of elaftic fluid: This fluid difplaces the milk, fo as nearly to empty the bottle in the fpace of two days: The acid produced by this fermentation, which takes place without the contact of air, feems to owe its oxigene, the acidifying bafe of air, to the decompofition of water.

The whey of fweet milk, feparated by rennet, without fouring, holds in folution a certain quantity of a faline fubftance, known by the name of falt or fugar of milk. Although Kempfer afferts, that the Brachmans have a procefs for preparing this falt, it appears, that Fabricius Bartholet or Bartholdi, an Italian phyfician, firft mentioned it to the world, in the year 1619. Etmuller, Tefti, Werlofchnigg, Wallifnieri, Fickius, and Cartheufer, have fuccefiively written concerning it, and defcribed procefles for its preparation. Meffrs Vulgamoz and Lichtenftein have given very particular accounts of the art of extracting this faline fubftance, which is prepared in the great way in different places in Switzerland. They there evaporate whey, obtained from milk, by fkimming it, and coagulating it with rennet, till it be reduced to the confiftency of honey: This fubftance, put into moulds, and dried before the fun, forms fugar of milk in tablets: thefe are diffolved in water, clarified with white of eggs, and evaporated to the confiftency of a fyrup; and then the liquor is cryftallized in the cold: white cryftals are formed in it, in rhomboidal parallelipipeds: the mother water depofites yellow and brown cryftals, which are purified by fuccefiive folutions.—M. Lichtenftein has examined and analyfed the different fugars of milk that are fold in Switzerland at different prices; and has particularly diftinguifhed, 1. *The fweet fugar of milk*, which is extracted from fweet purified whey: 2. *The acefcent fugar of milk*, obtained from four whey: 3. Sugar of milk, *rendered impure by a mixture of fat particles*, which, according to him, feparates in the firft cryftallization: 4. Sugar of milk, *mixed with oil and common falt*, which is laft cryftallized: 5. Sugar of milk, *mixed with fat particles, common falt, and fal ammoniac;* it is glutinous and moift; treated with fixed alkali,

alkali, it affords ammoniac: 6. Laftly, Sugar of milk mix-
ed with all the above-mentioned fubftances, *and likewife
with extractive and cafeous matter ;* this laft fugar is of
the confiftency of honey ; it is liable to turn rancid, and
is acrid and difagreeable.

Pure fugar of milk taftes, in a faint degree, like fugar,
infipid, and fomewhat earthy. By repeated folutions,
there is always fo much of it loft. It diffolves in three
or four parts of hot water : It affords, by diftillation, the
fame products as fugar, according to Meffrs Rouelle,
Vulgamoz, and Scheele. The firft of thefe chemifts
obtained, by burning a pound of this falt, from 24 to
30 grains of afhes; of which three fourths were muriate
of potafh, and the remaining fourth part carbonate of
potafh. On a burning coal, fugar of milk melts, fwells,
gives out a fmell of caramel, and burns like fugar.
Thefe properties afforded reafon for thinking, that this
falt would, like fugar, afford oxalic acid, if treated with
nitric acid. Scheele's experiments have confirmed this
conjecture : But he obferves, that a much more confider-
able proportion of fpirit of nitre is neceffary for this
purpofe, than to produce oxalic acid from common fugar;
and that 4 ounces of fugar of milk afford 5 drams of oxalic
acid : And he has farther difcovered, that the refidue of
fugar of milk that has been treated with nitric acid, when
diluted in water, and filtrated, in order to the evaporation
and cryftallization of the oxalic acid, leaves on the filter
a white powder, which he found to poffefs the charac-
teriftics of a peculiar acid different from the former. This
we denominate the *faccho-lactic acid.* The following are
its properties, as obferved by Scheele : ———

This acid is in the form of a white granulated pow-
der. Two drachms of this falt, in a ftate of confiderable
purity, on being expofed to heat in a glafs retort, melted,

fwelled,

fwelled, and turned black. There was fublimated from this matter, a brown falt, the fmell of which was a compound of the fmell of benzoin with that of amber, and which weighed 35 grains. That fublimate was acid, foluble in alcohol, but not fo eafily as in water, and burned on the coals. In the receiver, there was found a brown liquor, which poffeffed none of the characteriftics of an oily fubftance. In the retort, there remained 11 grains of coaly matter. Both carbonic acid, and hydrogenous gas, were difengaged during the diftillation. The faccho-lactic acid is fcarce foluble in water; for an ounce of boiling water diffolves only fix grains of it, and even of that quantity a fourth part is precipitated by cooling.—M. de Morveau fays, that this acid effervefces with an hot folution of carbonate of potafh. Saccholacte of potafh, cryftallized by cooling, was diffolved in eight times its weight of hot water, and cryftallized anew by the cooling of the liquor. Saccho-lacte of foda is fufceptible of cryftallization, and only five parts of water are requifite to diffolve it. This acid likewife combines with ammoniac; but heat deprives the neutral falt, thus formed, of its volatile bafe. · With barytes, aluminous earth, magnefia, and lime, the faccholactic acid forms falts which are almoft infoluble. It acts with little energy on metals; with their oxides it forms neutral falts, which are fcarce foluble. It precipitates nitrates of mercury, lead, and filver; as alfo muriate of lead.

When Scheele firft made this difcovery, he thought, that the white powder depofited by the oxalic acid, obtained from fugar of milk by the nitric acid, was nothing but calcareous oxalate, the formation of which was owing to lime which might poffibly be contained in this animal falt; but he was foon undeceived, when, on pouring a fmall portion of pure oxalic acid into a folution of

fugar

sugar of milk, he found the mixture to afford no precipitate. Yet M. Hermstadt, who, in Crell's Journal, has given two memoirs on sugar of milk, in the second of which he enters into a particular examination of this earthy acid, thinks, notwithstanding Scheele's experiments, that it must be a compound of oxalic acid and lime with a fat matter. But M. de Morveau, examining, with his usual accuracy, the experiments of this chemist, and comparing them with those of Scheele, has shewn, in the new *Dictionnaire Encyclopædique*, that M. Hermstadt has not accomplished his object, and that even the results of his experiments rather confirm than contradict the discoveries of the Swedish chemist. M. de Morveau has himself made several ingenious experiments, which concur to establish the same fact.—To these particulars we may add, that the oxalic and the saccho-lactic acids do not exist ready-formed in sugar of milk ; and that this salt contains only the bases which attract oxigene or the acidifying principle from the nitric acid. We may farther observe, that new experiments may, one day, perhaps, shew the saccho-lactic acid to be nothing but a modification of some other vegetable acid ; for, every thing tends to prove, that the principles of whey have belonged originally to the vegetables with which the animals that afford it are nourished.

Baron Haller represents sugar of milk as existing in the following proportions, in the milk of the following animals :

Four ounces of sheep's milk, afford from 35 to 37 grains of sugar of milk :

The same quantity of goat's milk -	from 47 to	49
———————— of cow's milk -	from 53 to	54
———————— of woman's milk	from 58 to	67
———————— of mare's milk -	from 69 to	70
———————— of ass's milk -	from 80 to	82

Rouelle has obferved, that after the fugar of milk is extracted from the whey of cow's milk, it cools into a fort of jelly ; and accordingly believes it to contain gelatinous matter.

The cheefe, or cafeous part of milk, is formed into a mafs, and feparated from the other parts of the liquid, by the action of fire, by the acid fermentation to which milk is liable, and by the intermixture of acids. This matter, when well wafhed, is white and folid, like the albumen of the blood. A gentle heat hardens it. By diftillation on a water-bath, it affords an infipid phlegm, fubject to putrefaction.

Dried cheefe affords, by diftillation in a retort, an alkaline phlegm, a ponderous oil, and a confiderable proportion of ammoniacal carbonate. Its coaly refidue is denfe, very difficult to incinerate, and incapable of affording fixed alkali. When treated with nitric acid, it is found to contain lime and phofphoric acid.

Cheefe putrefies in a hot temperature : It fwells, diffufes a noifome fmell, becomes half-fluid, and, in confequence of the difengagement of a ftrong-fmelling and highly mephitic gas, which with difficulty efcapes from this vifcid matter, is covered over with froth.

Cheefe is not foluble in cold water ; and hot water hardens it. Scheele has obferved, that when it has been precipitated by an acid, boiling water becomes capable of diffolving a part of it.

The alkalis diffolve it : ammoniac efpecially, when a few drops of it are poured into milk coagulated by an acid, caufes the *coagulum* in a fhort time to difappear.

Concentrated acids alfo diffolve cheefe. The nitric acid difengages azotic gas from it. The vegetable acids do not diffolve it in any fenfible degree. The folution of cheefe in the mineral acids is precipitated by alkalis;

of

of which, however, too great a quantity diffolves the precipitate again.

The neutral falts, efpecially muriate of foda, retard the putrefaction of this fubftance. Alcohol coagulates it.

From thefe particulars, it appears that cheefe is a fubftance, like the albumen of the blood.

Butter is in part feparated from milk by reft, and collected on the furface. But being, in this ftate, mixed with a good deal of ferum and cafeous matter, it is feparated from thefe matters by rapid agitation. This is the art of making or churning butter. The ferum which fwims over churned butter, ftill retains a portion of that oily fubftance ; it is yellow, four, and fat, and is called *butter-milk.* What is called *cream,* is a mixture of cheefe and butter, fkimmed off milk. It is much more difficult to digeft than pure milk. A confiderable agitation will reduce this fubftance into froth : in this ftate, it is called *whipped cream.*

Pure butter is foft and concrete, of a golden yellow colour, fometimes higher, fometimes lighter, and of an agreeable fweet tafte. By a gentle heat, it melts ; and by cooling, becomes folid. When diftilled on a waterbath, it affords an almoft infipid phlegm. In the retort, it affords an acid, of a very ftrong pungent fmell ; at firft, a fluid oil ; and afterwards, a concrete coloured oil, of the fame pungent fmell with the acid. When thefe products are rectified, the oil is rendered as fluid and volatile as effential oils. The refidual coal is but very fcanty. The acid which butter affords by diftillation, appears to be of the fame nature with that which is extracted from greafe ; of which we will hereafter fpeak, under the name of the *febacic acid.* It may alfo be extracted in neutral falts, by the application of lime, potafh, or foda.

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Butter,

Butter, in a hot temperature, eafily becomes acid and rancid. Its acid is then difengaged from a latent ftate, and is found to have a difagreeable tafte. Water and alcohol, by diffolving the acid, reduce the butter nearly to its former ftate. Fixed alkali diffolves butter, and forms a real foap with it.

From this detail of particulars, it appears, that butter is an oily fubftance, of the fame nature with concrete vegetable fixed oils.

Frefh butter is fweet, cooling, and relaxing ; but it eafily becomes four, and agrees but with few ftomachs. Brown butter, the acid of which is developed, is one of the moft unwholfome articles of food, and the moft diffi-cult to digeft, that can be made ufe of.

Milk is an aliment both agreeable and ufeful in a great many cafes. It is even one of the moft valuable medi-cines that can be prefcribed. In difeafes affecting the fkin or joints, fuch as the ring-worm, the gout, &c. it fweetens the acrid humours. It even heals up fome ul-cers that are not of a very malignant fort. It may be impregnated with the aromatic parts of plants : it is then an excellent medicine for the phthifis pulmonaris. All ftomachs are not fit for digefting milk : It is generally troublefome to people who are liable to the heart-burn, from too much acidity in the primary paffages : It fhould be almoft always adminiftered with great caution. Milk rendered medicinal, by feeding the animal which affords it on certain fubftances for that purpofe, is often ufed with fuccefs.

The milk of different animals poffeffes different virtues. Woman's milk is fweet, and highly faccharine, and pro-duces very happy effects in the cafe of a marafmus. Afs's milk is fuccefsfully ufed for the phthifis pulmonaris, and the gout ; it commonly relaxes. Mare's milk is

nearly

nearly of the fame nature with that of the afs. Goat's milk is ferous, and gently aftringent. Cow's milk is thicker, more fat, and more nourishing : it is alfo not fo eafily digefted ; and it is often neceffary to qualify it with water, or fome aromatic infufion, and that efpecially when it is found either not to pafs eafily through the body, or to occafion loofenefs.

Milk is likewife applied externally as an emollient. It fpeedily eafes pains; and contributes to ripen impofthumes, and gatherings of humour, by accelerating their fuppuration. It is applied hot, and in a bladder, to the fore parts.

CHAP.

C H A P. IV.

Of Fat.

THE Fat is a concrete oily matter, contained in the cellular tiffue of animals. It is either white or yellowifh, and commonly infipid as to both tafte and fmell. Its folidity, colour, tafte, &c. are different in different animals; nay, even in the fame animal, as it is older or younger. In the infant, it is white, infipid, and far from folid; in the adult perfon, firm and yellowifh; in the old man, of a deeper colour, very much diverfified in its confiftency, and generally of a ftronger tafte.

The fat of man and quadrupeds is confiftent, and either white or yellow: The fat of birds is finer, fweeter, more unctuous, and generally lefs folid: In cetaceous animals, and fifhes, the fat is almoft fluid, and generally difpofed in certain refervoirs, fuch as the cavity of the cranium, and the vertebræ. It is found, too, in ferpents, infects, and worms; but in thefe animals, it is confined to the vifcera in the lower part of the belly, where it is difpofed in fmall lumps: only a very fmall quantity of it is found on the mufcles, and under the fkin.

It

It has been obferved, that the fat of frugivorous and herbivorous animals is firm and folid, but that of carnivorous animals more or lefs fluid. It is, however, to be remarked on this head, that the fat muft always be lefs folid, and lefs concrete, in a warm living animal, than in a dead carcafe, cold, and under diffection.

The fat of an animal is different in its nature in different parts of the body. About the reins, and under the fkin, it is folid : It is lefs fo between the mufcular fibres, or near the moveable vifcera, fuch as the heart, the ftomach, and the inteftines. It is more copious in winter than in fummer. It feems to contribute to the maintenance of heat in thofe regions in which it is placed, as is proved by a great variety of facts that have been collected by phyfiologifts. It feems even to contribute to the nourifhment of animals, as has been obferved of the bear, the marmot, the dormoufe, and of all thofe animals in general which are occafionally conftrained to a long abftinence; for, on fuch occafions, their greafe is, by degrees, melted and wafted away.

Before ufing greafe in the making up of medicines, its chemical properties fhould be examined : it fhould be cut into pieces, and the membranes and veffels running through it feparated from it : it is next to be plentifully wafhed with water, and melted with a little water in a new earthen veffel. When the water is evaporated, and the boiling ceafes, it may then be poured into another earthen veffel, and fuffered to cool.

All the chemical properties of greafe have not yet been examined. Nothing but the power of fire, of air, and of fome re-agents, on this fubftance, is known : Yet there is fcarce any animal matter with which we need more to be well acquainted, in order that fome judgment may be formed of the ufes to which it is applicable, of
which

which there is nothing certain hitherto known; as well as of the alterations which it is liable to suffer in living bodies.

The fat of any animal is liquified by exposure to a gentle heat, and congealed by cooling. When exposed to a strong heat, with concourse of air, it diffuses a smoke of a poignant smell, which occasions tears and coughing; and it burns, when exposed to a heat sufficient to volatize it. It leaves but very little residual coal. Grease distilled on a water-bath, affords a vapid water, of a light animal smell, neither acid nor alkaline, but liable to take, in a short time, a putrid smell, as also to deposite mucilaginous filaments. This phenomenon, which takes place on all water obtained from animal substances by distillation on a water-bath, proves that the water carries off with it some mucilaginous principle to which the alteration must be owing. Animal fat distilled in a retort, affords a phlegm which is at first aqueous, but becomes afterwards strongly acid,—and oil that is partly liquid, partly concrete; and there remains a very small quantity of residual coal, which it is not easy to incinerate, and in which M. Crell found a small portion of calcareous phosphate. These products have an acid smell, lively and pungent, and as strong as that of the sulphureous acid. The acid is of a peculiar nature, and has been carefully examined by Mr Crell; but as it is exceedingly difficult to obtain it by distillation, that chemist employed a much surer and more expeditious process: we will speak of it afterwards. The concrete oil may be rectified by repeated distillation, so as to become highly fluid, volatile, and penetrating,—in a word, so as to exhibit all the characteristics of a genuine, essential or volatile oil. Twenty-eight ounces of human fat afforded Mr Crell twenty ounces, five drachms, and forty grains of fluid oil,—three ounces, three drachms,

and

and thirty grains of febacic acid,—and three ounces, one drachm, and forty grains of bright coal, nearly in the fame ftate with plumbago or carbure of iron, as was remarked by M. de Morveau. In this analyfis, there were five drachms and ten grains loft: That lofs muft have been owing to the water in vapour, and the elaftic fluids that were difengaged, as Mr Crell did not make ufe of any pneumato-chemical apparatus.

Greafe is very fpeedily altered, when expofed to the action of hot air: inftead of continuing fweet and inodorous, as when frefh; it becomes ftrong and pungent in its tafte, and abfolutely rancid. This alteration appears to be a real fermentation, by which the acid is developed, and placed in a free ftate. Although this acid, thus developed, feems to be of the fame nature with the febacic acid, I confider not the change as owing folely to the oily part of the greafe. The peculiar animal acid, difcoverable by a farther analyfis, may come in for its fhare in this alteration. The rancidity of greafe may be corrected in two ways: water itfelf, as has been obferved by Mr Pœrner, is capable of carrying off all the acid that it contains; alcohol, according to M. de Machy, has alfo the fame power. This proves, that the acid of rancid greafe reduces it into a fort of faponaceous ftate, in confequence of which it becomes foluble in water and alcohol. Either of thefe fluids may be therefore confidently employed to reftore rancid greafe to its original ftate.

When greafe is wafhed with a great quantity of diftilled water, the fluid diffolves a gelatinous matter, the exiftence of which appears upon evaporation; but the greafe ftill retains a certain portion of that matter intimately combined with it, on which its fufceptibility of fermentation depends. Farther, the power of water over

this

this animal fubftance has not yet been accurately afcertained.

Mr Crell, and the chemifts of Dijon, have afcertained in what manner alkaline fubftances act upon animal fat. Pure alkalis have long been known to form a fort of foap with fat. Mr Crell, by treating that foap with a folution of alum, or aluminous fulphate, feparated from it oil ; and by evaporating the liquor, obtained febate of potafh. This laft falt he diftilled with concentrated fulphuric acid, which difengaged the febacic acid. To feparate from that acid, the fulphuric acid combined with it, Mr Crell advifes to diftil it again on a fourth part of the febate of potafh, which muft be referved for the purpofe. To afcertain whether it be entirely purified from fulphuric acid, it may be affayed with acetite of lead. If the precipitate now formed be totally foluble in vinegar, it contains no fulphuric acid. The chemifts of the Academy of Dijon employ a fimpler procefs for obtaining the febacic acid : they melt the tallow, and, as it melts, throw into it quicklime : when this mixture becomes cool, they boil it in a large quantity of water : they next filtrate and evaporate the lixivium ; and, by this means, obtain calcareous febate, which is brown and acrid. To purify this falt, it is calcined in a crucible, diffolved, filtrated, and mixed with a juft proportion of water containing carbonic acid, in order to feparate, by precipitation, the fuperfluous lime : it is after this evaporated ; and affords, by evaporation, a white falt, which is diftilled with fulphuric acid, to difengage the febacic acid.

This acid exifts in the butter of cacao, in the white of the whale, and probably in all fixed vegetable oils. The following are its characteriftic properties : It is liquid and white, and its fmell very lively : it exhales white fumes : it is decompofable by fire, on which it becomes
yellow,

yellow, and affords carbonic acid : it converts blue colours to an high red : it unites with water in any proportion : with lime, it forms a cryftallizable falt; with potafh and foda, falts that cryftallize in needles, and remain fixed in the fire : it appears to act with the fame powers as the fyrupous acid on filiceous ftones, and on glafs. In union with the nitric acid, it diffolves gold; it acts upon mercury and filver; it precipitates nitrate and acetite of lead; it decompofes tartarite of potafh, by precipitating the tartareous acidulum, or cream of tartar; it alfo decompofes alkaline acetites. If ftrongly heated with fulphuric falts, the acid is feparated in a fulphureous ftate; it precipitates nitrate of mercury and filver. A number of thefe properties had induced Mr Crell to think, that the febacic acid might poffibly be nothing elfe but a modification of the muriatic acid; but M. de Morveau obferves, that, as it decompofes corrofive muriate of mercury, that property alone is enough to diftinguifh it from the muriatic acid.

Mineral acids, in a concentrated ftate, alter and burn greafe. The fulphuric acid turns it brown; the nitric acid gives it a lemon-yellow colour.

Sulphur combines very eafily with fat, and forms with it a combination that has not been yet fufficiently examined.

Greafe is capable of diffolving certain metals. It is united with mercury in the preparation known by the name of *mercurial pomatum*. To effect this union, all that is neceffary is, to triturate the metal with bear's greafe, or the fineft part of the fat of any other animal, for a confiderable time. By this operation, the mercury is divided, attenuated, and united with the greafe fo intimately as to give it a flate colour, and no longer appears, therefore, in a metallic form. This union, however, is partly nothing but an extreme divifion; or, at

leaft,

leaft, only a part of the mercury is diffolved by the fe-bacic acid ; for a magnifier fhews the globules of the mercury ftill exifting naked even in the beft-prepared ointment.

The three metals the moft liable to alteration by fat, are, lead, copper, and iron. The oxides of thefe metals, too, combine with it very readily. This is what makes it fo dangerous, to fuffer meats that have been prepared with fat to ftand for any time in copper difhes, or even in earthen difhes glazed with lead-glafs.——In combinations of animal fat with the oxides of metals, it is obferved, that the oxides pafs 'eafily, with the help of heat, into the metallic ftate. This is owing to the combination of the hydrogenous gas difengaged from the greafe, with the oxigene of the oxides.

Almoft all vegetable matters may be combined with fat. Extracts and mucilages render it, in fome degree, foluble in water, or at leaft contribute to its fufpenfion in that fluid. It combines with oils in any proportion, communicating to them a part of its own confiftency.

- Thefe are all the chemical properties which this fub-ftance is known to poffefs. From confidering them, it appears, that greafe is nearly of the fame nature with butter, being a fixed oil concreted by a difcernible quan-tity of acid, with oxigene.

As to its ufes in the animal œconomy;——befides main-taining heat in the parts around which it is difpofed, and giving an agreeable plumpnefs and roundnefs to the form, with a whitenefs to the fkin; Macquer thinks it likewife ferves to abforb the acids when too copious in the ani-mal body, and regards it as the refervoir of thefe falts. We are at leaft certain, that when too much acid is in-troduced into an animal body, it diffolves and melts the

fat,

fat, by communicating to it, no doubt, a faponaceous character, and rendering it more foluble.

Excefs, and, ftill more, alterations of the fat, occafion fatal diftempers in the animal œconomy, the fymptoms and effects of which are far from having been yet examined with fufficient accuracy. Lorry has ftudied them with particular attention ; and has fhewn, that there fubfifts a ftriking analogy between this fubftance and the bile.

Fat is ufed as a feafoning, and is nourifhing to people who have ftout ftomachs. In medicine, it is applied externally, as foftening and calming ; it enters into the compofition of ointments and plafters.

The marrow contained in the long bones, exhibits the fame properties with the fat ; but it has not yet been analyfed with fuch accuracy as might enable us to defcribe its charaèteriftic properties.

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C H A P. V.

Of the Bile and the Biliary Calculi.

THE bile or gall is a fluid, of a green colour, more or lefs yellowifh, of a very bitter tafte, and of a naufeous fmell, that is feparated from the blood in a glandulous part of the vifcera, univerfally known by the name of the *liver*. In moft animals, excepting infects and worms, it is collected in a membranous refervoir befide the liver, called the *gall-bladder*. The human bile has been but little examined hitherto, on account of its being fo difficult to procure a fufficient quantity of it. It is on the cow's that chemical experiments have been made.

Its confiftency is nearly gelatinous or flimy : it runs into threads, like a tolerably clear fyrup : when fhaken, it froths like foap.

When diftilled on a water-bath, it affords a phlegm that is neither acid nor alkaline, but liable to pafs, in a certain fpace of time, into a putrid ftate. I have often obferved in this phlegm a fingular property : I have found it to exhale a very difcernible fweet fmell, nearly

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the fame with that of mufk or amber. This experiment has been repeated a great many times in my laboratory. It fucceeds beft, in the diftillation of bile that has been kept for fome days, and is a little altered. When all the water that can be obtained from the bile on a water-bath is feparated from it, it is then found to be in the ftate of an extract, more or lefs dry, and of a deep embrowned green colour. This extract of bile attracts moifture from the atmofphere: It is very tenacious and pitchy; it may be entirely diffolved in water. By diftillation in a retort, it affords a yellowifh alkaline phlegm, an empyreumatic animal oil, a good deal of ammoniacal carbonate, an elaftic fluid mixed with carbonic acid, and hydrogenous gas: After this operation, there remains a coal of a confiderable bulk, which it is eafier to incinerate than any that we have yet mentioned.—According to M. Cadet, who, in the year 1767, prefented to the Academy a moft valuable Memoir on the Analyfis of the Bile, this coal contains carbonate of foda, an animal earth, and a fmall portion of iron. It is to be obferved, that the diftillation of this fubftance muft be flowly conducted; for it fwells confiderably. As to the falt, of which M. Cadet takes notice, as exifting in the coal of the bile, and thinks it to be of the fame nature with fugar of milk, it is eafy to fee, that fuch a matter could not refift the violent heat neceffary to reduce the bile into a carbonaceous ftate.

In a temperature of between 65° and 85° of heat, the bile is fpeedily altered: Its fmell becomes more naufeous; its colour is altered and deftroyed; whitifh mucilaginous flakes are precipitated from it; it lofes its vifcidity, and foon after acquires a foetid pungent fmell: When nearly putrefied, its fmell becomes fweet, like that of amber. My pupil, M. Vauquelin, has difcovered that

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the bile, after being heated on a water-bath, and thick-
ened a little, will remain unaltered several months, in
the same way as vinegar after being boiled. He has
likewise discovered, that altered bile, which exhales a
foetid smell, and is of a brown colour, dirty, and turbid,
loses its smell when heated ; and that some concrete al-
buminous flakes are then separated from it.

The bile dissolves very well in water. Its colour then
changes to a yellow, which is darker or brighter accord-
ing as the quantity of the water added is smaller or
greater.

All the acids decompose it in the same way as soaps :
the combination formed is a coagulum. This mixture,
filtrated and evaporated, affords a neutral salt, formed
of the acid that has been employed, and soda. This
beautiful experiment, for which we are indebted to M.
Cadet, proves the existence of soda in the bile. The
matter that rests on the filter, in these instances, is thick,
viscid, very bitter, and highly inflammable : its colour
and consistency are not always the same, but vary with
the nature of the acid employed, and the degree in which
it is concentrated. I have observed, that the sulphuric
acid gives it a deep green colour,—the nitric acid, a little
concentrated, a bright yellow colour,—and the muriatic
acid, a very beautiful light green ; but these colours
vary greatly with the state of the bile, and that of the
acids. This precipitate is a substance similar in its na-
ture to resins : On burning coals, it swells, melts, and
takes fire : in alcohol, it is totally dissolved ; and water
precipitates it, like the resinous juices. The action
of acids on the bile shews, therefore, that this sub-
stance is a true-soap, formed of an oil nearly of a resin-
ous nature, in union with soda. They prove also, that
there exists in this animal liquor, a certain quantity of
                                                    albuminous

albuminous matter. That matter is the caufe of the coagulation of the bile by fire, by acids, by alcohol, and by putrefaction.

Neutral falts, mixed with the bile, prevent it from paffing into a ftate of putrefaction.

Solutions of metals are decompofed by the bile, which they likewife decompofe. The fixed alkali of the bile unites with the acid of the folution ; and the coloured oil of the bile is precipitated in combination with the metallic oxide.

The bile combines readily with oils, and takes them up, as well as foap, from ftuffs.

This fluid is entirely diffolved in alcohol ; which feparates from it the albuminous matter. The tincture of the bile is not decompofed by water ; which fhews this fubftance to be a true animal foap, equally foluble in aqueous and fpiritous menftrua. Æther very eafily diffolves it.

Vinegar decompofes the bile, as well as the mineral acids. The liquor, filtrated and evaporated, affords acetite of foda in regular cryftals.

From thefe feveral facts it follows, that the bile is a compound, confifting of a good deal of water, a peculiar aroma, an albuminous mucilage, an oil of a refinous nature, and carbonate of foda. M. Cadet relates, that he found it to contain a falt, which he thinks to be of the fame nature with fugar of milk ; and the exiftence of that falt has been fince confirmed by M. Van Bochaute. But it is probable, that this pretended faline fubftance is rather analogous to the bright, cryftalline, foliated fubftance which has been found by M. Poulletier in the biliary calculi of the human body, and of which we are juft going to fpeak.

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The bile, confidered as it exifts in the animal œcono-my, is a juice which feems to promote digeftion. Its faponaceous nature enables it to make oily matters com-bine with water. Its bitter tafte fhews that it ftimulates the inteftines, and promotes their action on aliments. Roux, a celebrated phyfician and chemift of the Faculty of Paris, whofe premature death has been no inconfider-able lofs to both thefe fciences, thought that the princi-pal ufe of the bile was to carry off from the body the colouring part of the blood. It appears to be decompofed in the duodenum by the acids which almoft always exift or are developed in the organs of digeftion. It is cer-tain, at leaft, that it is greatly altered, efpecially in co-lour, when it forms a part of the excrements. Good phyficians, therefore, often draw very important induc-tions from an infpection of thefe matters, concerning the ftate of the bile in the inteftines through which it is con-ducted, and of the liver by which it is feparated.

The extract of the gall of the ox, and of feveral other animals, is ufed as an excellent ftomachic. It fupplies the deficiency, and quickens the inactivity of the bile : it ftrengthens the tone of the ftomach, giving it, when weakened, new vigour to perform its functions. But it muft be very cautioufly ufed ; for it is acrid and heating : it fhould always, therefore, be given in very fmall dozes, efpecially to people whofe nerves are delicate and eafily irritated. Some afcribe peculiar virtues to the gall of fifhes ; but the notion has not been confirmed by experience, and is therefore to be ranked among the too numerous clafs of thofe prejudices which difgrace the materia medica.

Of the Biliary Calculi.

WHENEVER the bile of the human body is, by any cause, detained in the veficle, efpecially when it is detained by fpafmodic contractions, as in cafes of melancholy, or hyfterics, long-continued grief, &c. it becomes thick, and produces brown concretions, which are light, inflammable, and of a very bitter tafte, and are called *biliary calculi*. Thofe concretions are often very numerous; they diftend the bladder, and fometimes fill it up entirely. They occafion violent hepatic colics, vomitings, jaundice, &c. I diftinguifh them into three varieties: Thofe which I include under the firft variety, are brown, blackifh, irregular, tuberculous, and feem to confift of lumps: Thofe of the fecond variety, are harder, brown, yellowifh, or greenifh, in concentric layers, and generally covered with a dry, uniform, grey cruft;—their form is commonly angular and polyhædral: The third variety confifts of white, ovoidal concretions, more or lefs irregular in their form, covered with a whitifh cruft, fcarce ever equally thick all over, in layers of a fpathofe appearance, or in tranfparent, cryftalline plates, generally radiated from the centre to the circumference.

The biliary calculi of the fecond variety have been examined by M. Poulletier de la Salle. He has obferved them to be foluble in alcohol. On digefting fome of them in ftrong fpirit of wine, he remarked the liquor, at the end of a certain time, to be full of minute particles, brilliant and cryftalline, and with all the appearances of a falt. The experiments which he made on this fubftance led him to fufpect that it might be an oily falt, in fome of its properties refembling the acid falt

with

with which, under the name of flowers of benzoin, we are already acquainted ; but it would rather appear that its nature is hitherto unknown. That philosopher could find this salt only in the biliary calculi of the human body, not in those of the ox. This very singular fact needs confirmation ; for M. Vauquelin and I have found a small quantity of lamellated matter in the biliary calculi of the ox.

M. Poulletier de la Salle's discovery has thrown light on some facts that were collected by the Royal Society of Medicine, concerning the stones formed in the gall-bladder. That Society received from their correspondents, some biliary calculi belonging to the third of the above-mentioned varieties, which had not then been described. They consisted of masses of transparent, crystalline plates, precisely of the same form with the matter discovered by M. Poulletier de la Salle. It even appears, that a large proportion of these crystals may be formed of the bile of the human body ; for the Medical Society have, in their collection of calculi, a gall-bladder entirely full of this transparent saline concretion. I have two others of the same kind, which I received from my colleagues, Messrs le Preux and Hallé. It is much to be wished that the nature of these newly discovered calculi were examined : researches on this head cannot but be of high service to the science of medicine.

Soap, a mixture of æther and oil of turpentine, &c. have been proposed as fit solvents for these biliary calculi. It is worthy of observation, that they are not found in the gall-bladder of the ox, unless after dry seasons, and a scarcity of fresh fodder, and disappear again in Spring and Summer, when those animals are supplied with plenty of green, succulent vegetables. Butchers are well acquainted with this fact ; they know, that

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between the month of November and the month of March thefe ftones are found in the animals, and from March to November ceafe to be found. This is a fufficient proof of the power of the faponaceous juices of plants to diffolve the biliary calculi. Yet, it is not to be thought that medicines, however active and volatile, can be conveyed into the gall-bladder in fufficient quantity to act there with the fame energy in diffolving the biliary calculi as in our experiments. In my opinion, the ceffation of fpafm, and confequently the dilatation of the biliary canal, is the true caufe of the good effects of the ærhereal mixtures that have been propofed by M. Durande, which I have elfewhere recommended to be made up without oil of turpentine;—with the more confidence, becaufe it is evident that the oil is both very heating, and produces no ufeful effect but that of diminifhing the volatility of the æther; and it has been already proved by fome obfervations, that yolks of eggs, and, no doubt, many other fubftances, will ferve the purpofe as well, without the fame unfavourable effects.

C H A P.

C H A P. VI.

Of the Saliva, the Pancreatic Juice, and the Gastric Juice.

ANATOMISTS and Physiologists have observed a great resemblance between the saliva and the pancreatic juice. The salivary glands, and the pancreas, are in fact precisely of the same structure; and the humours prepared by both these organs, appear to serve the same purpose. The human species and quadrupeds are the only animals that have saliva; at least, scarce any other animals have yet been found to possess salivary glands.

Chemists have not yet done any thing accurate on either of these fluids. The only reason that can be assigned for this, is its being so very difficult to procure even a very small quantity of either. We know only, that the saliva is a very fluid juice, separated by the parotides and many other glands, which is constantly flowing into the mouth, but most copiously during the act of mastication. This humour appears to be of a saponaceous nature, and impregnated with air, which renders it frothy. When evaporated to dryness, it leaves

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but little reſidue : And yet concretions of the ſaliva are ſometimes formed in the ducts by which it is conveyed into the mouth. It appears to coutain an ammoniacal ſalt ; for, lime and cauſtic fixed alkalis diſengage from it a poignant urinous ſmell.—Pringle, from experiments which he made, concluded the ſaliva to be very ſeptic, and that it promoted digeſtion, by occaſioning a commencement of putridity in the maſticated aliments. Mr Spallanzani, and ſome other modern naturaliſts, think, again, that it poſſeſſes, in an eminent degree, the power of retarding and ſtopping putrefaction.

The gaſtric juice is ſeparated from the ſmall glands or extremities of the arteries that open into the internal tunic of the ſtomach. The œſophagus ſupplies alſo a ſmall portion of it, eſpecially in the inferior region : in that region, many birds are obſerved to have very large glands that open into very diſcernible excretory ducts. M. Vicq d' Azyr has carefully deſcribed thoſe which appear in the ſtork, &c.

Some modern naturaliſts have been at great pains in examining the gaſtric juice. Meſſrs Spallanzani, Scopoli, Monch, Brugnatelli, and Carminati, ſome years ago, examined the properties of this liquor. They procured it from the ſtomachs of ſheep and calves, by opening them after the animals had faſted for ſome time. They obtained it from carnivorous and gallinaceous birds, by making them ſwallow metal tubes, perforated with holes, and filled with very fine ſponge. Mr Spallanzani examined the gaſtric juice of his own ſtomach, by making himſelf vomit, and by ſwallowing tubes of wood filled with different ſubſtances, that he might judge of the effects of the gaſtric juice upon each of them. Experiments with tubes had been before tried by M. de Reaumur. Laſtly, M. Goſſe of Geneva has had the courage to make himſelf vomit many times, by a certain proceſs of his own, which conſiſts in ſwal

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lowing air.—From all theſe modern obſervations, the gaſtric juice appears to poſſeſs the following properties:

This juice is the principal agent in digeſtion : It converts the aliments into a ſort of uniform ſoft paſte : It acts on the ſtomach even after the death of the animal : It acts as a ſolvent ; but, what diſtinguiſhes it from all other ſolvents, is, that it acts indifferently on animal and vegetable ſubſtances, without ſhewing any preference, or any ſtronger affinity with the one than with the other. Far from having a tendency to promote fermentation, it is one of the moſt powerful antiſeptics known. As to its intimate nature,—it appears, from the experiments of the above-mentioned philoſophers, to be different in different claſſes of animals. According to Mr Brugnatelli, the gaſtric juice of birds of prey and granivorous birds is very bitter, and conſiſts of a diſengaged acid, reſin, animal matter, and common ſalt : That of ruminating quadrupeds is very aqueous, turbid, and ſaltiſh ; it contains ammoniac, an animal extract, and common ſalt. M. de Morveau having digeſted in water, ſome parts of the interior tunic of the ſtomach of a calf, found them to diſplay an acid character. Mr Spallanzani thinks this character to be owing to the aliments on which the animal feeds : he never found the gaſtric juice of carnivorous animals, acid ; that of granivorous animals, he found always ſo. M. Goſſe experienced the ſame thing in himſelf, after living long on raw vegetables. Mr Brugnatelli thinks, that the white matter of the excrements of carnivorous animals contains phoſphoric acid ; but M. de Morveau obſerves, that his experiments are not concluſive. Mr Scopoli found in it ammoniacal muriate ; and ſuſpects, that the muriatic acid is produced by the operation of the vital powers of animals : But he has no deciſive fact to ſupport this opinion ; on the con-

trary,

trary, every fact concurs to evince that it proceeds from the aliments. Meffrs Macquart and Vauquelin have found the gaftric juice of the ox, the calf, and the fheep, to poffefs invariably an acid character ; but from the accurate experiments which they have made, it appears to derive this character from the phofphoric acid in a naked ftate. They have obferved, too, that thofe juices alter and putrefy even very fpeedily. The gaftric juice of carnivorous animals appears to poffefs antifeptic powers in a more eminent degree.

From all thefe facts taken together, it may be inferred, 1. That the gaftric juice is as yet but imperfectly known: 2. That it appears to be different in different claffes of animals, and modified according to the diverfity of the aliments on which they live : 3. That we have yet no proof of its being a peculiar acid, or that we fhould acknowledge the exiftence of a gaftric acid : 4. That its moft remarkable properties are, a very extraordinary folvent power, which acts with fufficient energy even on bony and metallic fubftances, and is even faid to be capable of attacking filiceous ftones,—with a fort of indifference on what matter it acts, and the fame affinity with all matters.

Its extraordinary antifeptic power, which it communicates to all bodies that are mixed with it, and which even ftops putrefaction in fubftances in which that procefs is already begun, has been more attended to than any of its other properties. Meffrs Carminati, Jurine, and Toggia, have applied the gaftric juice to wounds. Mr Carminati has even adminiftered it internally ; and they all agree with regard to its antifeptic powers. But the experiments of Meffrs Macquart and Vauquelin, above mentioned, which were made in my own laboratory, prove, that the gaftric juice of ruminating animals poffeffes no such properties.

C H A P.

C H A P. VII.

Of the Humours or Animal Matters that have not
yet been examined; such as Sweat, the Mucus of
the Nose, the Cerumen; Tears, the Gum of the
Eye, the Seminal Fluid, and the Excrements.

THERE are still many animal fluids and matters that
have not been examined : And therefore, rather
with a view to engage young physicians in such new and
useful researches, than to explain their nature, we shall
say something of the humour which transpires by the
pores,—the sweat, the mucus of the nostrils, the cerumen
of the ears, the tears, the gummy matter of the eyes, the
seminal fluid, and the excrements.

Physicians have discovered a great resemblance be-
tween the humour which transpires by the pores, and
the urine. They know, that on many occasions, both
these excretions serve the same purpose ; and are there-
fore naturally led to consider the vaporous fluid which
transpires by the pores as of the same nature with urine.
In the practice of medicine, its qualities are observed to

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be fubject to variation : Its fmell is faint, aromatic, alka-
line, or four ; its confiftency, fometimes glutinous, thick,
tenacious ; and it leaves a refidue on the fkin : It gene-
rally communicates to linen-cloth, a yellow colour, of
various fhades. I have twice obferved it to communicate
to linen, and woollen ftuffs, a fparkling blue colour.
M. Berthollet affirms, that fweat reddens blue paper ;
and obferves, that this phenomenon takes place chiefly
on parts affected with the gout. He takes it to contain
phofphoric acid. It has hitherto been found impoffible
to collect a fufficient quantity of this, excrementitial hu-
mour, for examining its properties carefully. A great
many experiments, therefore, remain to be made on this
matter, which only accidental and peculiar circumftances
can enable naturalifts to undertake and profecute.

The humour prepared by the membrane of Schneider,
which is thrown out of the nofe by fneezing, highly
merits the attention of phyficians. It is a fort of thick
mucilage, either white or coloured ; in certain affèctions,
efpecially in catarrhs, more or lefs fluid or confiftent.
Nobody has yet examined it.

The fame is the cafe with that fort of greenifh yellow,
or brown matter which gathers in the auditory canal,
becomes thick, and is, from its confiftency, known by
the name *cerumen.* It is very bitter : it feems to be of a
refinous nature : it is known to become fometimes fuffi-
ciently concrete to clofe up the auditory canal, and hin-
der found from entering it freely : it feems to be fome-
what of the fame nature with the inflammable matter of
the bile.

The fame is to be faid of the tears which are prepared
in a certain gland, fituated near the external angle of
the focket of the eye, and are defigned by nature to main-
tain the moifture and fupplenefs of the exterior parts.
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This liquor is clear, limpid, and difcernibly faltifh; it fometimes runs very copioufly: In the ordinary ftate of the human frame, it runs by degrees into the noftrils, and feems to ferve the purpofe of moiftening the mucus. Moft of the authors that have fpoken of this liquor of tears, particularly Pierre Petit, a phyfician in Paris, who, about the end of the laft century, publifhed a treatife on tears, confider them as being nearly pure water. The gum, or humour that adheres to the borders of the eye-lids, and feems to be feparated by the glands of Meibomius, is not better known than the tears.

The chemical nature of the feminal fluid has not been more particularly examined than that of thofe fluids above-mentioned. From the very few obfervations that have been made upon it, it appears to be nearly of the fame nature with animal mucilages, to be liable to become fluid either by cold or heat, and to be reducible by the action of fire, into a dry friable fubftance.

On this head, anatomical and microfcopical obferva-tions have gone much farther than chemical experi-ments. From thefe it appears, that the feminal fluid is a fort of ocean, with fmall round bodies fwimming about in it with great rapidity of motion. Thefe are, by fome, confidered as living animals intended for the re-production of the fpecies, and, by others, as organic particles which unite to produce a living animal. A late obferver has likewife difcovered, with the microfcope, cryftals that are formed during the cooling and evapora-tion of the feminal fluid. It muft be confeffed, however, thefe fine experiments have as yet contributed nothing to the advancement of the fcience, and have only given ground for fome ingenious hypothefes.

The aliments which animals fmallow, contain a great quantity of matter that cannot afford them nourifhment, and is

evacuated

evacuated from the inteftines in a folid form. The ex-
crements are coloured by a portion of the bile, which
they carry off with them. The fœtid odour which they
exhale, is owing to their having begun to putrefy in their
paffage through the inteftines. No chemift but Hom-
berg has examined thefe matters. He obferved the
phlegm obtained from the excrements, by diftillation on
a water-bath, to have a naufeous fmell : by wafhing and
evaporation, he obtained from them a falt which melted
like nitre, and kindled voluntarily in clofe veffels. This
matter, by diftillation in a retort, afforded the fame
products as other animal fubftances. From putrid ex-
crements he obtained an oil, deftitute of colour and
fmell, which did not gratify his expectations of feeing
mercury converted by it into filver.

It is to be obferved, that the fecal matter examined
by Homberg, was that of men fed upon coarfe bread
and Champagne wine ; which had been required as a
condition neceffary to the fuccefs of the alchemical expe-
riment he had been directed to make. The food muft
doubtlefs peculiarize, in fome degree, the nature of the
excrements, as thefe are nothing but the refidue of the
food.

C H A P. VIII.

Of Urine.

URINE is a tranſparent, excrementitial fluid, of a lemon-yellow colour, of a peculiar ſmell, of a ſaline taſte, ſeparated from the blood by two glandulous viſcera that are called the reins, and from theſe conveyed into a reſervoir univerſally known by the name of the bladder, in which it remains for ſome time : it is a ſort of lixivium impregnated with the acrid matters of the animal humours, which, if too long retained in the body, might obſtruct and diſorder the functions of the ſyſtem.

Urine is a ſolution of a great number of ſalts, and two extractive matters. It varies in quantity and in qualities, according to circumſtances. That of the human ſpecies, which we propoſe to examine more particularly, differs from the urine of quadrupeds. Among other claſſes of animals the differences are ſtill greater. The ſtate of the ſtomach, and particularly the ſtate of the humours, produce an infinite diverſity of changes on this fluid ; to aſcertain and eſtimate which, a long ſeries of experiments

would

would be requisite, which have, as yet, only been pointed out as necessary. Here, therefore, we shall. speak only of human urine as it is emitted in a state of health.

This fluid is, by good physicians, distinguished into two sorts. The one called crude urine, flows off soon after meals : it is clear, and almost entirely without taste or smell : it is far from containing so many different principles as the other. It, again, is called urine of the blood, or of concoction, and is not emitted till after digestion : it is separated from the blood by the reins ; whereas the other species appears to filtrate, in part, from the stomach and the intestines, directly into the bladder, thro' the cellular tissue, or the absorbent vessels.

The state of the health, and more especially the disposition of the nerves, modify the urine in a singular manner. After hysteric or hypocondriac fits, it flows copiously ; it is then inodorous, insipid, and colourless. Diseases of the bones and joints have considerable influence on this animal lixivium. It often deposites a great quantity of matter, apparently earthy, but which, as we shall hereafter shew, consists of lithic acid, and calcareous phosphate. The sediment of the urine of those who have the gout is of this sort. Physicians, particularly Heriffant and Morand, have observed, that when the bones are altered or softened, the urine deposites a good deal of this matter. It even appears, that the urine of people in a good state of health deposites a quantity of this matter, which constitutes the basis of bones ; which is probably all of it that is formed in the body above what is requisite for the nutrition and reparation of those organs.

Many of the articles of food communicate some peculiar properties to the urine. Turpentine and asparagus give it, the former a smell of violets, the latter a very

O 2   foetid

fœtid fmell. The urine of people of weak ftomachs retains a fmell of their food : bread, garlic, onions, foup, and all vegetables, communicate each its peculiar fmell to the urine. From thefe particulars, it appears, that an obfervation of the phænomena which urine exhibits, may be of confiderable ufe to the phyfician in the practice of his art. We muft, however, beware of imagining that, from fimple infpection of the urine, it is poffible for the phyfician to judge of the difeafe and fex of the fick perfon, and of the proper remedies ; as fome empirics pretend to do.

The urine of the human fpecies, confidered with refpect to its chemical properties, is a folution of a great many different fubftances. Some of thefe are falts, fimilar to thofe of minerals, and, as Macquer thinks, proceed from the aliments, without alteration. Others of them are matters of the fame nature with the extractive principles of vegetables : And laftly, fome appear peculiar to animals, and even to urine ;—at leaft, have not been found in any notable quantity among the products of the other kingdoms of nature, nor even in any other animal fubftances but urine. After explaining the proceffes employed to extract thofe different matters from urine, we fhall give the hiftory of fuch of them as are peculiar to the fluid, and therefore have not before come under our notice.

Urine ufed to be confidered as an alkaline liquor, or lixivium ; but M. Berthollet has remarked, that it always contains a greater quantity of phofphoric acid than of any other falt, and reddens the tincture of turnfole *. This phyfician has obferved, that the urine of gouty people

* Coldevillars had before afferted, in his *Courfe of Surgery*, that urine conftantly reddened the tincture of turnfole.

people always contains lefs acid falt than that of people in a ftate of perfect health; and that, during the fit of the gout, their urine is ftill lefs acid than at other times. Hence he conjectures, that in gouty people the phofphoric acid is not evacuated by the urine, as in people in perfect health ; that it lofes its way, (if the expreffion may be here ufed) and, being conveyed to the joints, there occafions irritation and pain. This excefs of acid in the urine appears to maintain in folution in it, a quantity of calcareous phofphate.

Scheele thinks the acid of urine not to be altogether phofphoric acid, but partly the fame with the acid of the calculus in the human bladder, which we call the lithic acid. This acid being fufceptible of concretion and cryftallization, forms, according to that celebrated chemift, the red cryftals that are depofited in urine, as well as the brick-coloured precipitate obferved in the urine of feverifh perfons. The tophaceous concretions on the joints of gouty perfons, appear to be of the fame nature with the calculus, that is, to confift chiefly of lithic acid.

Frefh urine, diftilled in the water-bath, affords a large quantity of a phlegm which is neither acid nor alkaline, but foon putrefies. As this phlegm contains nothing peculiar, urine is commonly evaporated by naked fire. In proportion as the water, which compofes more than feven eighths of this animal humour, is evaporated, the urine affumes a brown colour : there is feparated from it a pulverulent matter of an earthy appearance, which has been taken for calcareous fulphate, but is really a mixture of calcareous phofphate with lithic acid. This falt is of the fame nature with the bafis of bones, and the matter of the calculus in the bladder. When the

urine

urine has acquired the confiftency of clear fyrup, it is then filtrated, and removed into a cool place. In the courfe of a certain time, it depofites faline cryftals, confifting of muriate of foda, with two peculiar faline fubftances. Thefe laft falts are known by the name of *fufible falts, native falts of urine, alkaline phofphates, &c.*: their properties fhall be examined in the following chapter. Several different quantities of thofe cryftals may be obtained, by repeated evaporation and cryftallization. In thefe fuccefiive evaporations, a certain quantity of muriate of foda and muriate of potafh is cryftallized. When the urine ceafes to afford faline matter, it remains in the ftate of a very thick brown fluid, a fort of mother water, holding in folution two peculiar extractive fubftances. By evaporating this fluid to the confiftency of a foft extract, and treating the refidue with alcohol, Rouelle the younger difcovered, that one portion was foluble in alcohol, but another fuffered no folution in it. The firft of thefe matters he has called *faponaceous matter;* the fecond *extractive matter.*

The faponaceous fubftance is fomewhat faline, and fufceptible of cryftallization. It is difficult to make it dry; and, even when dry, it attracts moifture from the atmofphere. In the retort, it affords a quantity of ammoniacal carbonate equal to more than half its weight, a little oil, and fome ammoniacal muriate: Its refidue gives a green tinge to fyrup of violets.

The extractive fubftance, which is foluble in water, though not in alcohol, dries as eafily in the water-bath as the extracts of plants: it is brown, and not fo liable to deliquiate as the former falt: it affords, by diftillation, all the ufual products of animal matters. Such, according to Rouelle, are the characteriftic and diftinctive properties of thefe two fubftances which form the extract of urine.

urine. To thefe particulars we may add, that this ce-
lebrated chemift obtained from an ounce to an ounce
and a half of extract from a pint of urine of concoction;
whereas, the fame quantity of crude urine afforded him
only one, two, or three grains.

If, inftead of feparating this extract of urine into two
diftinct matters by alcohol, we diftil it altogether by
naked fire,—it affords a good deal of ammoniacal car-
bonate, an animal oil, and a little phofphorus. Its coal
contains a little muriate of foda, or common falt. This
analyfis of urine fhews, therefore, that the fluid confifts
of a large proportion of water, both phofphoric acid and
lithic acid in a difengaged ftate, muriate of foda, calca-
reous phofphate, phofphate of foda, and ammoniacal
phofphate, and two peculiar extractive matters which
colour the fluid. With refpect to the dark colour which
it acquires in various difeafes, efpecially in all cafes in
which the bile is affected, I have difcovered that it is
owing to the refin of the bile; and that the extract of this
urine, thus altered in colour, when diffolved by alcohol,
(that portion of it which is foluble in this menftruum)
is precipitated from it by water.

Urine, expofed to air, is altered the fooner, the hotter
the atmofphere. Sediments are firft formed in it fimply
by cooling: feveral faline matters are cryftallized at the
furface, and at the bottom of the liquor; and among
thefe, generally, a reddifh falt, which appears to be of
the fame nature with the calculus in the bladder. No-
body has obferved the fpontaneous alterations of this ex-
crementitial fluid with more attention than my colleague,
M. Hallé. In the decompofition which urine fuffers
when left to itfelf, he has diftinguifhed feveral different
periods at which fediments or cryftals of a different na-
ture are found depofited; as alfo the changes which the

O 4

fluid

fluid undergoes, in confequence of depofiting thofe fedi-
ments and cryftals. We cannot enter here into a detail
of thefe particulars, relative to the changes of the fluid,
and the matters which it depofites ; but the reader may
find them accurately defcribed in a valuable Memoir, in-
ferted among the Memoirs of the Royal Society of Me-
dicine for the year 1779. We fhall only mention here
the principal alterations which urine fuffers. Soon after
it becomes cool, its fmell alters, becomes more pungent,
and even ammoniacal ; its colouring part is changed, and
feparated from the reft of the liquor : at length the al-
kaline fmell goes off, and is fucceeded by another, not
fo pungent, but more difagreeable and naufeous : at laft
the decompofition is completely effected. Rouelle, the
younger, has obferved, that crude ferous urine does not
putrefy fo faft ; that its colour, when it is altered, is
greatly different from that of urine of concoction ; and
that at laft it is covered over with mouldinefs, like the
juices of vegetables, and the folutions of animal jelly.
M. Hallé has obferved fome urines to become highly
acid before paffing into a ftate of putrid decompofition.
Urine evaporated, after being fuffered to putrefy for a
year or more, affords fufible falt, as well as frefh urine ;
but it contains much more phofphoric acid in a naked
ftate, and effervefces with ammoniacal carbonate : a part
of its ammoniac has been volatilized by the putrefaction.
When it is evaporated, the falt that is depofited on the
fides of the veffel is highly acid ; and to obtain a larger
quantity of it, Rouelle, the younger, directs to add am-
moniacal carbonate, till the effervefcence entirely ceafe,
and the acid be completely faturated.

Quicklime and dry fixed alkalis inftantaneoufly decom-
pofe the faline principles contained in urine. Nothing
more is neceffary, than to pour cauftic potafh or foda, or

to caft quicklime into frefh urine, in order to make it
yield an infufferable putrid ammoniacal fmell. It is by
decompofing the ammoniacal phofphate, that thefe fub-
ftances produce fuch a fmell. M. Berthollet has difco-
vered, that lime-water produces, in frefh urine, a preci-
pitate from which phofphorus may be obtained. This
phenomenon is occafioned by the union of the lime-water
with the excefs of phofphoric acid : And the precipitate
is formed, 1. Of the calcareous phofphate that naturally
exifts in urine, and was maintained in folution only in
confequence of there being an excefs of phofphoric acid;
2. Of new calcareous phofphate, formed by the union of
the lime that has been added with the acid that was
before in a ftate of freedom. M. Berthollet having ob-
ferved, that cauftic ammoniac likewife precipitates cal-
careous phofphate from urine, by neutralizing the naked
phofphoric acid by which that falt was held in folution,
remarks, that the weight of this precipitate, compared
with that which is produced by lime-water, indicates the
quantity of naked phofphoric acid contained in the urine;
for, in fact, the ammoniacal phofphate formed on this
occafion remains diffolved in the fluid, whereas the cal-
careous phofphate produced by lime-water is precipitated,
as infoluble, at the fame time with the calcareous phof-
phate naturally exifting in the urine.

The acids produce no effects on frefh urine : but they
fpeedily deprive putrid urine of its fmell ; and they, in
the fame manner, deftroy the fmell of the fediments
which it depofites in that ftate.

Urine decompofes many folutions of metals. Lemery
has made known, under the name of *the rofe-coloured pre-
cipitate*, a magma, of a rofe colour, that is formed by
pouring the nitric folution of mercury into urine. That
precipitate is formed partly by the muriatic acid, and
partly

partly by the phofphoric acid contained in the fluid. M. Brongniart has obferved, that fometimes this preparation takes fire by friction, and that it burns with rapidity on burning coals,—phænomena which he afcribes to its containing a fmall portion of phofphorus.

Such is the ftate of our prefent knowledge concerning the chemical properties of urine. Much yet remains to be done, before we can obtain all the information concerning this matter that analyfis is capable of furnifhing. The feveral fediments that have been obferved in urine, and fo accurately diftinguifhed by M. Hallé, fhould be analyfed : The red or tranfparent faline concretions that are formed in it, and have been taken by Scheele for lithic acid, fhould alfo be analyfed ; and in like manner, the copious fediment which urine affords after fits of the gout, from perfons afflicted with the ftone, &c.

We fhall, however, in the following chapter, examine the feveral faline products that urine affords, with the properties of which phyficians ought to make themfelves well acquainted.

C H A P. IX,

*Of the Ammoniacal Phosphate, the Phosphate of Soda,
and the Stone in the Bladder, or the Lithic Acid.*

WE have feen, that urine contains certain peculiar
falts. Thofe are combinations of phofphoric
acid with ammoniac, foda, lime, and the acid bafe of the
ftone in the bladder. Continuing to ufe, for thefe fub-
ftances, the methodical denominations already mentioned,
we fhall fucceffively examine the ammoniacal phofphate,
the phofphate of foda, and the lithic acid. As to the
calcareous phofphate, we fhall defcribe its properties
under the article *Bones.*

The falt obtained from evaporated urine by cooling
and reft, has been called in general *fufible falt ;* becaufe,
as we fhall immediately fee, it melts in the fire : it has
been alfo called *effential falt of urine, microcofmic falt.* In
this primary ftate, it is a mixture of ammoniacal phofphate
and muriate, and of muriate of foda, contaminated with an
extractive matter. Several chemifts, particularly Margraf,
have been of opinion, that, to avoid the mixture of ma-
rine falt, the urine muft be fuffered to putrefy ; and the
<div align="right">marine</div>

marine falt is, by the putrefaction of the urine, changed
into phofphate. That opinion has been fince proved to
be falfe : 120 pints of frefh urine afford, according to
Margraf, about four ounces of ammoniacal phofphate,
and two ounces of phofphate of foda.

It is not eafy to effect an entire feparation of thefe
fubftances of which the fufible falt confifts, that is ob-
tained by a firft cryftallization, and was confidered by
Schockwitz, Le Mort, Boerhaave, Henckel and Schloffer,
as a fingle falt. To accomplifh this feparation, it has been
recommended to diffolve the falt in hot water, evaporate,
and cryftallize it. But Rouelle the younger, and the
Duke of Chaulnes, are the only chemifts that have men-
tioned a very great and uncommon difficulty with which
this procefs is attended : Moft of the falt is carried off
by the heat of the folution and evaporation, and about
three fourths of it is loft. The Duke of Chaulnes has
given a procefs for purifying it with as little lofs as
poffible; which confifts in filtrating the folution, and leav-
ing it to cool in clofe-ftopped veffels. By either of thefe
manipulations, there is obtained, firft, a falt cryftallized
in rhomboidal tetrahædral prifms, very much compreffed,
which is ammoniacal phofphate ; and, above thefe firft
cryftals, another falt, in cubes, or rather oblong fquare
tables, very different from the former falt in fhape ;
this, again, is phofphate of foda. This laft falt, as has
been remarked by Rouelle the younger, may alfo be
feparated, by taking off the efflorefcence that gathers on
the former falt, which is liable to no fuch alteration.

Of

Of the Ammoniacal Phosphate.

THE ammoniacal phofphate, thus purified and fepa-
rated from the phofphate of foda, is in the form of
rhomboidal tetrahædral prifms, much comprefſed, and
generally truncated in their length, and at the angles:
in confequence of thefe circumftances, the prifms are,
in fome meafure, hexagonal. There are likewife often
enough found, according to M. Romé de Lille, from
whom I take my defcription of this falt, longitudinal feg-
ments of the prifms, of which fegments the fide that lies
on the capfule is the broadeft; it is alfo rhomboidal, and
interfected by two diagonal lines, crofſing at the middle.
The tetrahædral and octahædral form afcribed to it, ap-
pears only while this falt yet retains muriate and phof-
phate of foda. The power of communicating the octa-
hædral form feems to belong peculiarly to the muriate of
foda; for, when the former falt is diffolved in urine,
and the liquor expofed to the fun, regular octahædral
cryftals are obtained in the courfe of a few days. The
tafte of ammoniacal phofphate is at firft frefh, and after-
wards urinous, bitter, and pungent: When heated with
the blow-pipe on a burning coal, it fwells, diffufes a
fmell of ammoniac, and melts into a deliquefcent vitreous
globule: When diftilled in a retort, the heat difengages
from it fome very pungent and cauftic ammoniac: the
refidue is a very fixed and fufible tranfparent glafs, which
corrodes the retort. Margraf fays, that it is foluble in
two or three parts of diftilled water, and exhibits the
properties of an acid. Rouelle affirms it to be deliquef-
cent. M. de Morveau, again, thinks, that, with the help
of

of a good fire, it may be reduced into an unalterable vi-
treous ftate.   M. Prouft has difcovered, that this vitreous
refidue is a combination of phofphoric acid with a pecu-
liar matter which he does not feem to have known, and
which is nothing but phofphate of foda, as appears from
the refearches of feveral modern chemifts.   But it is to
be obferved, that this compound glafs is only obtained
when the ammoniacal phofphate diftilled ftill retains a
portion of phofphate of foda ; and that, in this cafe, the
glafs appears to be always opaque, or liable to be very
eafily rendered opaque, whereas pure ammoniacal phof-
phate leaves a very tranfparent glafs.

. Ammoniacal phofphate is not liable to be altered by
the action of air.

, It appears to be very foluble in water, only five or fix
parts of cold water being requifite to maintain it in folu-
tion.   Hot water, at the temperature of 170 degrees,
decompofes it, and even volatilizes a part of its acid.

. Ammoniacal phofphate acts as a flux on filiceous earth,
aluminous earth, barytes, magnefia, and lime : But thefe
vitreous compounds are owing to the phofphoric acid ;
for the ammoniac is difengaged before the fufion takes
place.

Lime, and the two fixed alkalis, in a pure ftate, de-
compofe ammoniacal phofphate, and feparate the ammo-
niac.   Lime-water, poured into a folution of this falt,
produces a white precipitate, which can be nothing but
calcareous phofphate.   Alkaline and earthy carbonates
likewife decompofe it, and feparate the ammoniac in the
ftate of ammoniacal carbonate.

, The effects of the mineral and vegetable acids on am-
moniacal phofphate, have not as yet been examined with
fufficient care.   It muft depend on the various elective
attractions which exift between the phofphoric acid and
                                                      its

its alkaline bafe : We fhall treat of it when we come to fpeak of that acid.

The fame is the cafe with refpect to the alterations which ammoniacal phofphate fuffers from metals, and metallic oxides; for thofe alterations depend entirely on the phofphoric acid.

Ammoniacal phofphate, treated with coal in clofe veffels, affords phofphorus. Bergman propofes the ufe of it as a flux, in affays with the blow-pipe.

Of Phofphate of Soda.

WE have defcribed the manner in which phofphate of foda is obtained. It will be proper to give the dates of the different difcoveries concerning it, before we proceed to examine its properties.

Hellot, in the year 1737, feems to have been the firft who mentioned it ; but he took it to be fulphate of lime. Haupt, in the year 1740, gave a better account of it, under the name of *fal mirabile perlatum.* Margraf defcribed it in the year 1745. Pott made mention of it in the year 1757, but, like Hellot, took it for fulphate of lime. Rouelle, the younger, examined it in the year 1776, and gave it the name of *fufible falt, with a bafe of natrum.* All of thefe chemifts perceived this falt to be different from the laft, chiefly by obferving, that it did not afford phofphorus with coal. But Rouelle has diftinguifhed its properties better than any of the reft. According to him, its cryftals are flat, irregular, tetrahædral prifms, with one of the extremities dihædral, and

and confifting of two rhomboids, the other adhering to the bafe. The four fides of the folid are two alternate irregular pentagons, and two oblong rhomboids, cut flope-wife.

Phofphate of foda, expofed to heat in a crucible, melts, and affords a white, opaque mafs. When heated in a retort, it affords nothing but phlegm, without any acid or alkaline character; and the refidue is an opaque glafs, or frit.

In the air, this falt efflorefces, and falls all down into duft.

It diffolves readily in diftilled water, and cryftallizes by evaporation: the folution turns the fyrup of violets green.

Calcareous nitrate decompofes it: a precipitate of calcareous phofphate is formed; and the fupernatant liquor affords nitrate of foda.

This falt is equally liable to be decompofed by the nitric folution of mercury. It forms a white precipitate, which, when diftilled in a retort, affords a little reddifh fublimate, and fome running mercury, and leaves in the bottom of the retort, an opaque white mafs, adhering to, and combined with the mercury. This mercurial precipitate forms again phofphate of foda, when boiled with a folution of carbonate of foda, and leaves the mercury in the ftate of a brick-red powder. Such are the facts which the younger M. Rouelle difcovered concerning this falt. M. Prouft, being engaged by that celebrated chemift, whofe pupil he was, in a new examination of this matter, made a great many experiments upon it; of which the following are the principal refults. On lixiviating the refidue of phofphorus, formed from fufible falt of the firft cryftallization, from which he had obtained no more phofphorus but what was equal to an

eighth

eighth part of the weight of the salt, the lixivium afforded, by evaporation in the open air, parallelogrammatic cryſtals, an inch in length, and in the proportion of five or ſix drachms to the ounce of the fuſible ſalt from which the phoſphorus was formed. It is to be obſerved, that this proportion would not be ſo great, were it not for the water that enters into the cryſtals. This ſubſtance melts in the fire into an opaque glaſs: it communicates a green colour to flame: it effloreſces in the air: it decompoſes nitrates and muriates, by diſengaging the acids: it forms glaſſes with earthy matters, by fuſion: it ſaturates alkalis, like an acid. From theſe facts M. Prouſt concluded this ſaline ſubſtance to be different in nature from all that he was before acquainted with,— to be combined with phoſphoric acid, and ammoniac in ammoniacal phoſphate,—and to form, with ſoda, Rouelle's *fuſible ſalt with a baſe of natrum.* He obſerved, that it performed the functions of an acid, and compared it to the boracic acid. On this idea, M. Prouſt made new experiments on the fuſible ſalt with a baſe of natrum, obtained by Rouelle's proceſs, above deſcribed.

According to him, lime decompoſes this ſalt; having a greater affinity than ſoda with the peculiar ſubſtance which performs in it the functions of an acid. Limewater poured into a ſolution of this ſalt, produces a precipitate; and the ſoda is left in ſolution, in a pure cauſtic ſtate.

The mineral acids, and even diſtilled vinegar, decompoſe it, in a way directly contrary to this. Rouelle ſuppoſed, that the ſulphuric and the nitric acids did not act on this ſalt, becauſe they produced upon it no viſible change; but M. Prouſt, on mixing the ſulphuric, the nitric, the muriatic, and the acetous acids, with a ſolution of *fuſible ſalt with a baſe of natrum,* obſerved, that

although there was no precipitate formed in thefe'mix-
tures, yet the liquors, when evaporated and cooled, af-
forded fulphate and nitrate, muriate and acetite of foda :
which proves, 1. That the falt has been decompofed by
thefe acids : 2. That it contains foda, as had been before
fhewn by the younger Rouelle. As to the feparate fub-
ftance which was before in union with the foda, it is
plain that it remains in folution in the liquors, together
with the new neutral falts. M. Prouft diftinguifhed it
very plainly in the mother-water, obtained after the
mixture of vinegar with the folution of the fufible falt,
and the cryftallization of the acetite of foda. By pouring
on that mother-water, eight or ten times its bulk of alcohol,
the laft portions of the neutral acetous falt are diffolved,
and a magma is formed, which muft be wafhed with a
new quantity of alcohol, and then diffolved in diftilled
water. This folution of the magma, when evaporated
in the open air, affords parallelogrammatic cryftals, pre-
cifely like thofe which are obtained by wafhing the refi-
due of phofphorus, formed from fufible falt of the firft
cryftallization, from urine. It is therefore, according to
M. Prouft, a peculiar fubftance, of the fame nature
with the boracic acid, which faturates the foda, in fufible
falt with a bafe of natrum. This difcovery feems to ex-
plain the reafon why this falt does not afford phofphorus.
To thefe particulars M. Prouft added, that it was a new
fubftance, which exifted always in true fufible falt, or
ammoniacal phofphate, and communicated to the phof-
phoric acid the property of melting into a glafs; and
for this reafon, I gave it, in the firft edition of this
work, the name of *the bafe of phofphoric glafs*. But M.
Morveau has fince been convinced, on fufficient evi-
dence, that the pure phofphoric acid, obtained from
phofphorus by deliquefcence, and confequently contain-
ing

ing none of that fubftance, is fufible, by heat alone, into
a folid and permanent glafs. This feries of experiments
which M. Prouft made with great care, and of which the
refults are particularly ftriking, induced Bergman to con-
fider this fubftance as a peculiar acid : He gives a hifto-
ry of it in the fecond edition of his Differtation on Elec-
tive Attractions, under the name of *acidum perlatum*, de-
rived, no doubt, from the denomination given by M.
Haupt, in the year 1740, to fufible falt with a bafe of
natrum. M. de Morveau has introduced it, as a diftinct
article, into his Chemical Dictionary, under the name of
the *ouretic acid*, from the Greek name of urine, which
affords it. But, fince M. Prouft's experiments, Berg-
man's Differtation, and the compilation of M. de Mor-
veau's article, M. Klaproth has publifhed, in M. Crell's
Journal, an analyfis of *fufible falt with a bafe of natrum*;
which annihilates this pretended peculiar acid, and fhews
it to be nothing but phofphoric acid in combination with
foda. Mr Klaproth difcovered this truth by fuch ano-
ther experiment as that of the younger Rouelle. On
precipitating the folution of *fufible falt with a bafe of
natrum*, by calcareous muriate or nitrate, the precipitate
which Rouelle had before mentioned as analogous to the
bafe of bones, actually affords phofphoric acid by means
of fulphuric acid. Mr Klaproth adds, that, on faturat-
ing phofphoric acid, obtained by the flow combuftion of
phofphorus with foda, with a fmall excefs of the foda,
there is a falt formed, precifely of the fame nature with
Haupt's *fal perlatum*, or Rouelle's *fufible falt with a bafe
of natrum;* and that, in order to obtain the fubftance
defcribed by M. Prouft, nothing more is neceffary but to
deprive this neutral falt of its excefs of foda, by vinegar,
or to add to it a little phofphoric acid. After this, we
need not be furprifed to find Bergman reprefenting the

affinities

affinities of the *acidum perlatum*, as precifely the fame
with thofe of the phofphoric acid. This detail of parti-
culars has been given by M. de Morveau, in a fupple-
ment to the acids of the mineral kingdom ; and he grants,
that after this, the *ouretic* acid, and *ouretic* falts, are no
more to be mentioned.

It is very extraordinary, that phofphate of foda is
not decompofable by coal, like ammoniacal phofphate ;
—that coal cannot deprive the phofphoric acid, when in
union with foda, of its oxigene. This bafe, therefore,
renders this acid incapable of being decompofed by coal ;
although it does not act in the fame way on the fulphu-
ric, and various other acids. This is a ftriking excep-
tion from the general law of the attractive elections of
oxigene, of which no other inftance is yet known. It is
not lefs remarkable, that an excefs of phofphoric acid,
added to phofphate of foda, leaves to that compound,
which, according to Mr Klaproth, is the peculiar fub-
ftance of M. Prouft, the power of rendering fyrup of
violets green.

M. de Morveau adds to the hiftory of phofphate of
foda, that a folution of muriate of lead poured into a
folution of this falt, produces a precipitate of phofphate
of lead. This laft falt, by diftillation with coal, affords
phofphorus ; as M. de Laumont, infpector of the mines,
has difcovered with an ore from the mines of Huelgoet.
From this it appears, in what manner corneous lead, the
ufe of which, in the diftillation of phofphorus of urine,
has been propofed by Margraf, may augment the quan-
tity of the product, as we fhall explain in the following
chapter.

Of the Lithic Acid.

THE calculus or ftone that is formed in the human bladder, has long engaged the attention of chemifts and phyficians. Paracelfus, who gave it the barbarous name of *duelech*, imagined it to confift of an animal refin, and compared it to arthritic concretions. Van Helmont thought it a concretion formed of the falts of urine, and an earthy volatile fpirit ; and believed it to be of a very different nature from arthritic chalk, the formation of which was, in his opinion, owing to the thickening and acidification of the fynovia. Boyle extracted from it, oil, with a good deal of volatile falt. Boerhaave admitted in it the exiftence of an earth in union with volatile alkali. Hales extracted from it 645 times its own bulk of air ; and out of 230 grains, obtained no more than 49 grains of refidue : He called it *animal tartar*. Many learned phyficians, and efpecially Whyte and Deften, have confidered alkaline matters as the true folvent of the urinary calculus. Several even propofed the ufe of the foap-makers' lixivium for that purpofe. But none of thefe notions was founded on an exact analyfis of the calculus. Scheele and Bergman firft undertook fuch an analyfis.

The former of thefe chemifts difcovered, that the ftone in the bladder confifts moftly of a peculiar acid, to which we give the name of the *lithic acid.* 70 grains of the calculus in the bladder afforded him, by diftillation, 28 grains of this acid, in a dry and fublimated ftate,—fome ammoniacal carbonate,—and 12 grains of coal, which he

found

found it very difficult to reduce to afhes. 1000 grains
of boiling water diffolved 296 grains of the fame acid:
This lixivium reddened blue colours; but the greateft
part feparated in fmall cryftals by cooling.

Concentrated fulphuric acid diffolves the calculus, with
the help of heat; and paffes, in confequence of effecting
this folution, into the ftate of concentrated fulphureous
acid. The muriatic acid does not act upon it; the nitric
diffolves it entirely: nitrous gas and carbonic acid are
difengaged, while this laft folution is taking place. This
folution is red; it contains a naked acid; it communi-
cates a red tincture to the fkin, and all organic tiffues:
When tried with foluble barytic falts, it exhibits no mark
of its containing fulphuric acid,—nor of lime, when tried
with oxalic acid. Lime-water forms in it a precipitate,
which diffolves, without effervefcing, in acids. Cauftic
alkalis, according to Scheele, diffolve the calculus: thefe
folutions are precipitated by lime; 1000 grains of lime-
water diffolve 537 of any of thefe precipitates; and am-
moniac, in a large proportion, acts in the fame manner
on the calculus. That celebrated chemift afferts, that
the brick-coloured fediment in the urine of people in a
fever, is of the fame nature. Although Scheele found
no lime in the ftone of the bladder, yet Bergman obtained
fome from it, by precipitating the nitric folution with
fulphuric acid, and calcining the refidue of the fame fo-
lution. Bergman likewife difcovered in the calculus, a
white fpongy matter, infoluble in water, acids, or al-
kalis: The incinerated coal of this fubftance, of which
the quantity was fo fmall that he could not afcertain its
nature, is not even foluble in nitric acid.

From this analyfis by two fuch celebrated philofophers,
which has been again and again repeated by different
chemifts, the ftone in the bladder appears to be of a dif-
ferent

ferent nature from the earth of bones. Yet Mr Tennant, Fellow of the Royal Society of London, has found in the bladder, ftones which loft only two thirds by calcination, and whofe refidue melted into an opaque glafs by cooling. Thefe muft therefore have contained a pretty confiderable quantity of calcareous phofphate.

As to the lithic acid,—the properties which it is known to poffefs, are, 1. That of being concrete and cryftalline: 2. That of being almoft infoluble in water, but more foluble in hot than in cold water: 3. That of being foluble in nitric acid, from which it abforbs oxigene, and forming, after this folution, a deliquefcent red mafs, which communicates a colour to many bodies: 4. That of combining with earths, and metallic oxides; and forming with them peculiar neutral falts, which we call *ammoniacal lithiate, lithiate of copper, calcareous lithiate, lithiate of potafh, lithiate of foda,* &c.: 5. The property of preferring, in its attractions, alkalis to earths: 6. Laftly, That of yielding thefe bafes to the weaker of the other acids, even to the carbonic acid, which renders the calculus infoluble by alkaline carbonates; this laft property is peculiar to this acid. But, as M. de Morveau has very well obferved, much remains to be done before we can obtain a fufficient knowledge of the lithic acid; and, I may add, even before we can determine whether it be not a modification of fome other acid; which may be fufpected from what we know concerning the relations of the vegetable acids to one another, and the identity of the pretended *acidum perlatum* and *ouretic acid,* with the phofphoric acid.

M. de Morveau thinks the concretions at the joints, which phyficians have confidered as of the fame nature with the calculus of the bladder, to be, in their nature, very different from it. But his opinion is founded only

P 4

on fome experiments of Schenckius, Pinelli, and Whyte, which were far from being performed with due accuracy and attention : And the obfervations of Boerhaave, Frederic Hoffman, Springsfield, Alfton, Leger, &c. concerning the good effects of alkaline waters, foap, and lime-water, in arthritic and calculous cafes, have, with me, greater weight in eftablifhing the analogy between thefe two forts of concretions, than the others in deftroying it. There is, however, no refufing to agree with M. de Morveau, that experiments only can determine the quefion. This is a new proof of the beneficial influence of chemical refearches on the fcience of medicine, and the advantages which it may derive from them.

CHAP.

C H A P. X.

Of Kunckel's Phofphorus.

PHOSPHORUS is one of the moft combuftible fub-ftances known. As it was firft extracted from urine, and as the matter which affords the moft of it is ammoniacal phofphate, it feems therefore moft fuitable to give the hiftory of this inflammable fubftance in this place.

The difcovery of phofphorus is owing, according to Leibnitz, to an alchemift of the name of Brandt, a citizen of Hamburgh, who found it out in the year 1667. Kunckel, to gain the knowledge of the procefs, affociated with a man of the name of Krafft: But Krafft not communicating to him the fecret, Kunckel refolved to fearch for it himfelf; and after many experiments on urine, from which he knew it to be obtained, he at laft produced phofphorus, and was confidered as being truly the difcoverer of it. Some alfo afcribe the honour of this difcovery to Boyle, who, in the year 1680, actually gave a fmall quantity of it into the hands of the Secretary to the Royal Society of London. But Stahl afferts,

that

that Krafft had told him, that he communicated his pro-
cefs for making phofphorus to Boyle. Boyle communi-
cated his procefs to a German, whofe name was Godfreid
Hankwitz, who had an excellent laboratory at London,
and was the only man that prepared phofphorus, and
fold it, through all Europe. Although, between the
year 1680, and the beginning of the prefent century,
there were produced many receipts for making phof-
phorus, and, among others, Boyle's, Krafft's, Brandt's,
Homberg's, Teichmeyer's, Frederic Hoffman's, Niewen-
tyt's, and Wedelius's; yet no chemift had hitherto pre-
pared it openly; and the preparation was ftill quite a
fecret, when, in the year 1737, a ftranger offered to com-
municate, at Paris, an infallible procefs for making phofpho-
rus. The Academy named four chemifts, Meffrs Hellot,
Dufay, Geoffroy, and Du Hamel, to try the procefs in the
laboratory in the King's garden. The procefs fucceeded.
The minifter beftowed a reward on the ftranger; and
Hellot gave an accurate account of the procefs, in a Me-
moir, inferted among the Memoirs of the Academy for
the year 1737. This procefs confifts in evaporating five
or fix hogfheads of urine, till it be reduced to a granu-
lated, hard, black, gliftering matter,—calcining the refidue
in an iron pot, red-hot in the bottom, till fuch time as it
ceafe to fmoke, and take the fmell of peach-flowers,—
lixiviating this matter with, at leaft, twice as much hot
water,—and drying it, after decanting off the water.
Three pounds of this matter muft be mixed with a pound
and an half of coarfe fand, or pounded ftone-ware, and
four or five ounces of powder of charcoal of beech.
This mixture is to be moiftened with half a pound of
water, and introduced into an Heffian retort. The mat-
ter is affayed, by making a portion of it red-hot in a
crucible: If it exhibit a violet flame, and diffufe a fmell
of

of garlic, it will afford phosphorus. The retort is placed in a furnace made on purpofe; and a large balloon, about one third of which muft be filled with water, adapted to it. The balloon muft be perforated with a fmall hole; and Hellot confidered this as one of the manipulations that are the moft neceffary for the fuccefs of the operation. Three or four days after the apparatus has been fet up, a moderate fire is kindled under it, to dry the furnace and the lutings: by degrees, the fire is augmented, and it is kept for fifteen or twenty hours in this ftate. The phofphorus does not diftil till fourteen hours after the beginning of the operation, which lafts, in all, twenty-four hours. There arifes, firft, a large quantity of ammoniacal carbonate, a part of which is diffolved by the water in the balloon. Volatile or aeriform phofphorus paffes, firft, in luminous vapours: the true phofphorus then runs, like an oil, or melted wax. When it ceafes to pafs, the apparatus muft be left to cool for two days. The luting muft then be taken off; and water added, to loofen the phofphorus adhering to the fides of the receiver: It is next melted iu boiling water; for which purpofe, it is cut into fmall pieces, which are introduced into the necks of matraffes, cut towards the middle of the body into the form of a funnel, and immerfed in boiling water. The phofphorus melts, is purified, and rendered tranfparent by the feparation of a blackifh matter which rifes above it. It is then put into cold water, in which it congeals; and it is now thruft out of the matraffes with a fmall ftick.——Such, in fhort, is the procefs defcribed by Hellot. The tedioufnefs of the operation hindered it from being repeated by any chemifts but Rouelle, the elder, who, in his courfes of chemiftry, went through it feveral times with fuccefs.

In

In the year 1743, Margraf publifhed, in the Memoirs
of the Academy of Berlin, a new method for making, at
once, a pretty large quantity of phofphorus, eafier than
had been done before him. In this procefs, the corneous
lead which remains from the diftillation of four pounds
of *minium*, and two pounds of ammoniacal muriate, is
mixed with ten pounds of extract of urine, of the con-
fiftency of honey. A pound and an half of powder of
charcoal is next to be added to it. The mixture muft
be dried in an iron pot, till it be converted into a black
powder. This powder is to be diftilled in a retort, in
order to extract from it, by a graduated fire, the ammo-
niacal carbonate, the fœtid oil, and the ammoniacal mu-
riate which it contains. Care muft be taken, however,
to urge it with fire no farther than juft to make the re-
tort red-hot. The black friable refidue of this diftilla-
tion, is the matter from which the phofphorus is ex-
tracted. It is affayed, by cafting a little of it on burning
coals. If it diffufe a fmell of garlic, and a blue phof-
phoric flame, it may then be confidered as well prepared.
A retort of Heffian or Picardy earth is filled three-fourths
full of it, and well luted. This veffel is then placed in
a reverberating furnace, with a dome, and an iron
chimney, fix or eight feet high. A middle-fized receiver,
perforated with a fmall hole, and half-full of water, is
fitted to the retort. The joinings muft be luted with fat
lute, and covered with fillets of cloth dipped in white
of eggs, and lime: A brick-wall muft be raifed between
the furnace and the receiver; and after this apparatus
has been fuffered to dry for a day or two, the diftillation
may be carried on by a properly graduated fire. This
operation lafts from fix to nine hours, according to the
quantity of the matter to be diftilled. The phofphorus,
thus obtained, is rectified by diftilling it by a very mo-
derate

derate fire, in a glafs retort, with a receiver half-full of water. Almoft all chemifts have repeated Margraf's procefs fuccefsfully : and it was the only one in ufe, till, within thefe few years, another was difcovered, which confifts in feparating the phofphoric acid from bones; as we fhall mention when we come to fpeak of thofe folid bodies.

It appears, that the only thing in which Margraf's procefs differs from Hellot's, is in the addition of the mu- riate of lead, and the divifion of the operation into two. But, what is of moft importance in the ingenious chemift of Berlin's procefs, is, that it determines the nature of the fubftance contained in urine, which ferves for the form- ation of phofphorus. By diftilling a mixture of *fufible falt* with charcoal, he obtained excellent phofphorus ; and he obferves, that the urine from which he had ex- tracted that falt would yield no more of this combuftible fubftance. That fubftance, therefore, which contributes to the formation of phofphorus, muft be a conftituent part of fufible falt ; and indeed phofphorus is eafily ob- tained by diftilling two parts of glafs obtained from the decompofition of fufible falt in a retort or crucible, with one part of powdered charcoal. This operation requires much lefs time, and much lefs fire, than any that we have yet defcribed ; for, according to M. Prouft, the phof- phorus is ready to run in a quarter of an hour. This, doubtlefs, is the beft procefs that can be ufed to obtain phofphorus of urine. But there are feveral obfervations to be made on this head : 1. The vitreous refidue, re- maining after the decompofition of ammoniacal muriate by fire, not being pure phofphoric acid, but phofphoric acid in combination with phofphate of foda, which is not decompofable by coal, only a very little phofphorus can, therefore, be obtained, by employing this refidue,—an

ounce

ounce of it affording no more than a drachm, and often
lefs : 2. When fufible falt is prepared in any large quan-
tity by evaporation and cooling, it is found to be mixed
with a confiderable proportion of foda, which affords no
phofphorus. Thefe two obfervations may be, therefore,
confidered as explaining, why fo little of this combuftible
body is obtained by the diftillation of fufible falt with
coal. Perhaps, fufible falt in its original ftate, or the
mixture of ammoniacal phofphate with phofphate of foda,
if diftilled with coal and muriate of lead, would afford
more phofphorus ; for muriate of lead appears to be ca-
pable of decompofing phofphate of foda.

Phofphorus, by whatever of thefe proceffes obtained,
is ftill the fame. When very pure, it is tranfparent,
and its confiftency like that of wax. It cryftallizes by
cooling, into brilliant plates of a micaceous appearance.
In hot water, it melts a confiderable time before the
fluid be heated to ebullition. It is highly volatile, and
rifes in a thick fluid by a moderate heat. In contact
with air, it exhales a fmoke from every part of its fur-
face : this vapour diffufes a ftrong fmell of garlic, and
appears white in day-light, and in the dark very lumi-
nous. It is a flow inflammation of the phofphorus from
which it proceeds ; and when left for any time expofed
to the air, phofphorus is gradually confumed, and leaves
as a refidue a peculiar acid, the properties of which we
will afterwards examine. This flow combuftion never
takes place but when the phofphorus is in contact with
air : Nay, to render it very luminous, a heat from twelve
to fifteen degrees of Reaumur's thermometer, or about
fixty-three degrees of Fahrenheit's, is requifite ; al-
though the inflammation may take place under that tem-
perature. This inflammation is not accompanied with
heat, nor does it kindle any other combuftible body.

But,

But, when phofphorus is expofed to a dry heat of 24 degrees Reaumur, or 86º Fahrenheit, it kindles with decrepitation : it burns rapidly with a very lively white flame, mixed with yellow and green, and deftroys very fpeedily any combuftible body that comes within its influence. The vapours which then exhale from it are very copious, white, and very luminous in the dark. This rapid combuftion takes place with a very ftrong heat, and a very fparkling light, in a receiver full of vital air.

In thefe two different forts of combuftion, phofphorus leaves different refidues. The firft affords a liquor weighing more than twice as much as the phofphorus employed on the occafion, which we call the *phofphorous acid.* The fecond gives a very deliquefcent and foluble, white, concrete matter, which is the *phofphoric acid.* This laft was thought to refemble the acid and fluid refidue of the firft combuftion, or the flow inflammation : But the two acids exhibit real differences in their combinations, as was firft obferved by Margraf, and has been fhewn by M. Sage, in the Memoirs of the Academy for the year 1777. We will fpeak more particularly of thefe differences in the hiftory of the two acids.

The combuftion of phofphorus was confidered by Stahl as the difengagement of the phlogifton which he thought to be combined with muriatic acid * in that combuftible.

* Stahl, in feveral of his works, has afferted, that phofphorus may be compofed by combining muriatic acid with phlogifton. Margraf engaged in a feries of experiments with a view to this ; in which he treated various combinations of the muriatic acid with combuftible matters ; but could never fucceed. He has even fhewn, in a fatisfactory manner, that the acid formed by the burning of this combuftible body, is very different from that of marine falt ; and all chemifts are now of the fame opinion.

buftible body. M. Lavoisier, in order to diftinguifh what happens in this combuftion, kindled, with a burning-glafs, a quantity of phofphorus in a bell-glafs immerfed in mercury. He obferved, that no more than a given quantity of this matter can be burnt in a certain bulk of air ; that the quantity amounts to one grain of phofphorus to fixteen or eighteen cubic inches of air ; that, after this combuftion, the phofphorus is extinguifhed, and the air rendered unfit to contribute to the combuftion of a new quantity of phofphorus ; that the bulk of the air is diminifhed, and the phofphorus converted into white, fnowy flakes, which fix on the fides of the bell-glafs : Thofe flakes are equal to twice and one half more, the weight of the phofphorus from which they are formed ; and this increafe of the weight of the phofphorus correfponds exactly to the diminution of weight which the air has fuffered, and is owing folely to the abforption of phofphorus by the oxigene. In fact, the white flakes are concrete phofphoric acid, produced by the combination of phofphorus with the oxigene, or bafe of vital air, contained in the atmofpheric air which has contributed to the combuftion of that inflammable fubftance. The theory of this fubftance is the fame with that of fulphur ; and it is therefore unneceffary to make any addition here to what was faid on that head, in the mineral kingdom.

Phofphorus becomes liquid in hot water. Vital air, paffed through phofphorus thus liquefied in water, burns it, and reduces it into the ftate of phofphoric acid.

Phofphorus, though not foluble in this fluid, yet fuffers, by degrees, an alteration in it. It lofes its tranfparency, becomes yellow, and is covered over with an efflorefcence, or coloured duft. The water becomes acid, and

and appears luminous when shaken in the dark. The phosphorus is then slowly decompofed.

Cauftic fixed alkalis diffolve phofphorus, with the help of a boiling heat. While this combination takes place, there is a foetid gas difengaged that was firft difcovered by M. Gingembre, and poffeffes the fingular property of kindling with an explofion, when brought into contact with atmofpheric air, and more inftantaneoufly ftill, when brought into contact with vital air. This elaftic fluid confifts of phofphorus diffolved in hydrogenous gas; and the hydrogenous gas is produced by the decompofition of the water. We call it *phofphorated hydrogenous gas.*

Sulphuric acid, diftilled in a retort, with phofphorus, burns almoft entirely away, but without emitting any flame. Concentrated nitric acid acts upon it with violence, and, if the phofphorus be hot, kindles it fuddenly. When this experiment is made in a retort, with nitric acid not very highly concentrated, the phofphorus burns flowly, robs the nitric acid of its oxigene, and forms phofphoric acid. This procefs was defcribed by M. Lavoifier in the year 1780.

The muriatic acid, even though oxigenated, does not act in a fenfible degree on phofphorus.

Nitric falts, with the help of a gentle heat, kindle it with great rapidity.

Sulphur and phofphorus combine, according to Margraf, by fufion and diftillation. The refult is a folid compound, of a foetid fmell, which burns with a yellow flame, and, in water, fwells, and communicates to it the acidity and fmell of alkaline fulphures; which properties fhew, that thefe two bodies react on each other in a peculiar manner, as their union feems to occafion the decompofition of water.

Phosphorus does not combine so well as sulphur, with metals, though there be, in many particulars, a strong analogy between phosphorus and sulphur. Margraf attempted to form these combinations by distilling each of the metallic substances with two parts of phosphorus. None but arsenic, zink, and copper exhibited peculiar phænomena. None of the other metals was at all altered by the phosphorus, which was partly burnt or sublimated in the receiver, without suffering any discernible change.

Phosphorus sublimated with arsenic, afforded that celebrated chemist, a matter of a beautiful red colour, not unlike realgar.

Zinc, distilled twice in succession with this combustible substance, afforded yellow flowers, punctuated and very light. The sublimate, when exposed to the action of fire, under a red muffle, kindled, and melted into a transparent glass, like that of borax.

Copper, treated in the same way with phosphorus, lost its brilliancy, and became very compact. Its weight was increased sixteen grains in the half drachm, and it burnt when exposed to flame. M. Pelletier has observed, that copper combines very well with phosphorus, and that the result of this combination is a sort of grey ore, brilliant, granulated, very hard, and very difficult to melt. To these compounds into which phosphorus enters unaltered, we give the name of *phosphures* of copper, zinc, arsenic, iron, &c.

The Marquis de Bullion and M. Sage have described a remarkable alteration which phosphorus suffers in metallic solutions. The first of these chemists discovered, that small pieces of phosphorus, introduced into solutions of gold, silver, copper, &c., were gradually covered with a crust, or a sort of bright metal case. These elegant

elegant experiments fhew, that phofphorus has a greater affinity with oxigene than feveral of the metals, and is capable of reducing their oxides. Bergman has eſtabliſhed it as an unqueſtionable fact, that the arſenical acid is blackened and reduced into the ſtate of arſenic when heated with phofphorus; which, at the fame time, as it deprives the femi-metal of its oxigene, is converted into phofphoric acid.

Phofphorus is foluble in all oils; and renders them luminous. Spielman has difcovered, that it diſſolves in alcohol, and that the folution emits fparks, when poured into water. In this operation, a part of the phofphorus is precipitated in a white powder.

Phofphorus has not yet been ufed, either in medicine or in the arts. Meſſrs Menzius, Morgenſtern, Hartman, &c. fay, that they have found it to produce good effects in malignant and bilious fevers, when the ſtrength has been exhauſted, and in the miliary fever. Some authors have recommended it in the fcarlet fever, the peripneumony, rheumatic pains, epilepfy, &c.; but, though, in Germany, feveral diſſertations have appeared, on the medicinal virtues of phofphorus taken internally, yet nothing can be affirmed as certain on this head, till ſuch time as experience ſhall pronounce concerning it in a more decifive manner.

Q 2 CHAP.

C H A P.   XI.

Of the Phofphoric and the Phofphorous Acids.

THE phofphoric acid has been fo called, becaufe it
was thought to exift ready-formed in phofphorus,
from which it is obtained by combuftion.   But M. La-
voifier has proved this falt to be a combination of fulphur
with oxigene.—There are four different proceffes for
obtaining this acid.   The firft confifts in burning phof-
phorus haftily, under bell-glaffes, full of atmofpheric air,
and immerfed in mercury, by the heat of a burning glafs, or
by touching it with a red-hot iron.   Care muft be taken,
to put a little water on the fides of the glaffes before
the procefs commence.   This procefs, invented by M.
Lavoifier, affords, in a fhort time, a quantity of phof-
phoric acid, mixed with a fmall quantity of unburnt
phofphorus, that is, of acid in part phofphorous.   Vital
air may be ufed in this act of combuftion.   In truth, the
inflammation is fo rapid and fo violent, as often to break
in pieces the glaffes with a noife.   This procefs affords
phofphoric acid,

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The fecond procefs, which we owe to Meffrs Woulfe and Pelletier, is performed by paffing a ftream of vital air through phofphorus melted under water.

In the third, given by M. Lavoifier, the phofphorus is burnt by means of nitric acid, not very ftrong.——— Both thefe proceffes produce phofphoric acid.

The fourth procefs, a flow combuftion, which has been improperly called the formation of phofphoric acid by *deliquium*, is very well defcribed by M. Sage.— Sticks of phofphorus are placed on the fides of a glafs funnel, the ftalk of which enters a bottle; and its bafe is covered with a capital, the extremity of which remains open. A tube of glafs is put into the neck of the funnel, to prevent the phofphorus from efcaping, and to afford, at the fame time, a paffage, through which the air, difplaced by the acid, may move off. Care muft be taken to keep the fticks of phofphorus from touching each other, and to prevent the temperature of the place in which the apparatus ftands from rifing above fixty degrees; otherwife the phofphorus may probably deflagrate. In more or lefs time, there is obtained by this procefs, for every ounce of phofphorus, three ounces of acid, which collects and flows, by degrees, into the water in the bottle: it is phofphorous acid.

Thefe four proceffes afford acid of phofphorus, in two different ftates, according as the phofphorus is either not decompofed, or entirely burnt and faturated with oxigene. Thefe two acids, between them, exhibit phænomena, which may be compared to thofe of the fulphuric and the fulphureous acids.—Such is the origin of the differences between the refults obtained by Meffrs Sage and Lavoifier, in the combinations of this acid, which are related in the Memoirs of the Academy for the year 1777. As already mentioned, we diftinguifh the former, that

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in which the phofphorus is faturated with oxigene, by
the name of the *phofphoric acid ;* and the fecond, which
is not entirely faturated with oxigene, we call the *phof-
phorous acid.*

Of the Phofphoric Acid.

PURE phofphoric acid, obtained without the addition
of water, and in vital air, is in the form of white flakes,
fnowy, light, deliquefcent, and of a very ftrong acid tafte.
When expofed to the air, it fpeedily attracts moifture.
When brought into contact with a little water, it eafily
melts, and affords a white fluid, without fmell, of an oily
confiftency, very ponderous, of a tafte ftrongly acid, and
capable of changing blue vegetable colours rapidly into
red. If expofed to the action of fire in a retort, it affords
a pure phlegm : the acid then concentrates, and becomes
even more ponderous than the fulphuric acid : it affumes,
by degrees, confiftency and opacity ; it is then like a foft
extract. Laftly, when urged with a violent heat, it melts
into a tranfparent glafs, which is hard, highly electric,
and infoluble, but exhibits none of the properties of an
acid. It appears, that this folid vitreous ftate of the
phofphoric acid, is owing to a more intimate combination
taking place between the acidifiable bafe and the oxi-
gene, and to the feparation of a part of the latter.
This idea, of a more intimate adherence taking place be-
tween the oxigene and the acidifiable bafe in phofphoric
glafs, which, as it is no longer acid, merits the name of
vitreous phofphoric oxide, is confirmed, when we obferve

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how difficult it is to obtain from it phofphorus, with the help of coal, and how ftrong a heat muft act on this mixture, to produce the defired effect.

Phofphoric acid obtained by flow combuftion, or phofphorous acid, when heated in an open veffel, emits, from time to time, a faint flame, which is owing to its ftill retaining a refidue of phofphorus that has not been all burnt, and the flame is accompanied with a fmell of garlic. It then is concentrated, becomes dry, and at laft melts like the former acid.

The concentrated phofphoric acid very fpeedily attracts moifture from the atmofphere. It combines with water, with the help of heat: it combines with a great many fubftances; and, in its combinations, exhibits fome peculiar phænomena.

The liquid phofphoric acid does not appear to have any power over filiceous earth, according to the experiments of Bergman and M. de Morveau: But it has been fhewn by Dr Prieftley and Mr Ingenhoufze, to act on glafs.

The blow-pipe makes it bubble with aluminous earth. Phofphoric acid, when melted in Heffian crucibles, has been remarked, by M. de Morveau, to communicate to them a tranfparent vitreous covering.

It combines with barytes, and feems to prefer it to all other bafes but lime, if the affinities of this acid have been rightly marked by Bergman. The properties of barytic phofphate are ftill unknown.

The phofphoric acid diffolves carbonate of magnefia, with effervefcence. The falt which it forms with this fubftance is fcarce foluble. A concentrated folution of it affords, by reft, in the fpace of four and twenty hours, fmall flat needle cryftals, very flender, feveral lines in length, and cut obliquely at the two ends: it often takes

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liquefcent. I have obferved, in this thick matter, needles difpofed in radii, which indicate a beginning of cryftallization: But a little more foda than what is requifite to faturate the acid, added to this falt, inftantly effects a change of its properties: its tafte now becomes urinous; it turns fyrup of violets green, cryftallizes in large parallelograms, and efflorefces in the air; in a word, it acquires all the properties of the fufible falt with a bafe of natrum, which we call *fuperfaturated phofphate of foda.* This falt does not afford phofphorus with coal; and neither phofphate of barytes, of lime, of potafh, nor of foda, is liable to fuch a decompofition: Wherefore it appears, that the phofphoric acid muft be in a naked difengaged ftate, in order to be decompofed by coal.

The ammoniacal phofphate produced by the combination of phofphoric acid with ammoniac, is more foluble in hot than in cold water, and affords, by cooling, cryftals, which, according to M. Lavoifier, bear fome refemblance to thofe of alum. I have remarked, that when the combination is truly neutral, it is very difficult to obtain it in cryftals; for it is almoft all evaporated even by a moderate heat. But an excefs of ammoniac is favourable to the cryftallization of this falt: A little phofphate of foda produces the fame effect; and this is the ftate of that extracted from urine. Barytes, lime, and alkalis, decompofe ammoniacal phofphate: Fire eafily difengages the ammoniac; and accordingly, this falt affords phofphorus with coal.

The phofphoric acid decompofes alkaline fulphates, nitrates, and muriates, by the dry way; and, by its fixity, difengages the acids: but, in the humid way, it yields its bafes to thefe acids.

The phofphoric acid, in a fluid ftate, acts only on a few metallic fubftances. It diffolves zink, and iron, and

<div align="right">copper,</div>

copper, readily enough.   None of thefe folutions affords
cryftals by evaporation, except the folution of iron,
which, indeed, feems fufceptible of cryftallization.   The
others form into foft du&ile maffes, like extra&s : when
urged with fire, they emit fparks, and appear to form
genuine phofphorus.   Margraf, and the Academicians
of Dijon have examined the different phænomena exhi-
bited by this acid, in its a&ion on metals and femi-
metals.

The phofphoric acid likewife precipitates fome folu-
tions of metals, fuch as the folutions of mercury and
filver by the nitric acid.

The nitric and acetous folutions of lead are, in like
manner, liable to be precipitated by phofphoric acid, and
by foluble phofphates.   The precipitate produced by the
decompofition of the latter, which is phofphate of lead,
affords phofphorus, when diftilled with coal.

This acid re-a&s upon oils, and improves their ·fmell.
To oils not naturally fweet-fmelling, it communicates a
fweet fmell, in fome degree æthereal : fome of them it
thickens.

When diftilled, in its dry ftate, with coal, it affords
phofphorus.

By heating it in a retort, with alcohol, the Academi-
cians of Dijon obtained a liquor highly acid, of a pun-
gent and difagreeable fmell, which burnt with a little
fmoke, and exhibited fome of the properties of æther.
The phofphoric acid became volatile in this experiment,
for the produ& was acid. M. Lavoifier obferved heat
produced by this mixture.   Moft chemifts, however,
confider the phofphoric acid as infoluble in alcohol.
Margraf, Rouelle, Scheele, Meffrs Wenzel, Laffonne,
Cornette, and the Duke de Chaulnes, recommend the ufe
of alcohol to purify the phofphoric acid, and feparate
                                                        from

from it any extraneous matters which it may happen to contain.

Laftly, phofphoric acid, holding in folution phofphate of foda, affords, by fufion, an hard glafs, infipid, info-luble, not deliquefcent, and opaque, refembling that which fufible falt leaves when urged with fire.

We may add farther, that the phofphoric acid, which was formerly thought peculiar to urine, exifts in a great many animal matters, as we have already feen, and as will farther appear in the fucceeding chapters. Margraf informed the world of his having found it in vegetables. M. Berthollet has extracted it from fuch as afford ammo-niac by diftillation : M. Haffenfratz, from a great many plants growing in marfhes, and on peat-earth. It has been found in various minerals, particularly in lead and iron, with which it appears to be combined in confe-quence of the decompofition of animal fubftances. Laftly, M. Prouft has found it in combination with lime, in a fparry ftone, in Spain.

Of the Phofphorous Acid.

IT has been related, that when phofphorus burns flowly, and is not completely faturated with oxigene, there is an acid formed different from that whofe hiftory we have juft finifhed, and bearing to it the fame relation which the fulphureous bears to the fulphuric, the nitrous to the nitric, and the acetous to the acetic acid. This difference between thefe two acids, in the proportion of oxigene that enters into their compofition, occafions a wide difference between their properties, in the fame manner

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as in the other fix which correspond, two and two. The phosphorous may be also considered as phosphoric acid, holding in solution a little phosphorus. This acid, when rubbed, and, still more, when heated, takes a fœtid and disagreeable smell : part of it is then volatilized, in a very acrid and pungent white vapour : it is then more volatile than phosphoric acid. But this acid never rises all in vapour, like the sulphureous acid ; it always contains more or less phosphoric acid, which causes it to leave a vitreous residue, or a melted phosphoric oxide, when treated with a strong fire. It may be prepared by decomposing phosphoric acid ; and in the production of phosphorus, there is always a certain quantity of it disengaged. The distinctive properties of the phosphorous acid have not been all, as yet, particularly examined ; but enough is known of them, to mark the difference that prevails between this and the phosphoric acid. M. Sage, in the Memoirs of the Academy for the year 1777, has given an account of some of the characteristic properties of the phosphorous acid. According to that chemist, the salt formed by the union of the acid obtained from phosphorus by *deliquium*, with potash, or phosphate of potash, is not deliquescent : Phosphate of soda is also crystallizable, but not deliquescent ; but ammoniacal phosphate attracts moisture from the atmosphere.

CHAP.

C H A P. XII.

Of the Soft and White Parts of Animals, and of their Muscles.

ALTHOUGH lefs progrefs has been made in the analyfis of the folid parts of animals, than in the analyfis of animal fluids, yet we are beginning to know fomething of the different matters of which they are compofed. In the firft place, we know, that difference of texture both indicates and occafions a difference in conftituent principles. This affertion will be confirmed, by a comparative examination of the foft and white parts, with the mufcles and bones.

All the foft and white parts of animals, fuch as the membranes, the tendons and aponeurofes, the cartilages, the ligaments, and the fkin, contain, in general, a mucilaginous fubftance, which diffolves readily in water, but is infoluble in alcohol, and is known by the name of *jelly.* To extract this jelly, nothing more is requifite than to boil thefe parts of animals in water, and to evaporate the decoction, till it form, by cooling, into a folid tremulous mafs. When evaporated by a more violent heat, it

<div align="right">affords</div>

affords a dry, brittle, tranfparent fubftance, that is known by the name of *glue*.

Glue is prepared from all the white parts of animals. The fkin, the griftles, and the feet of cows, are ufed in the preparation of a ftrong glue, in England, Flanders, Holland, &c. The fkin of the eel is the bafis of gilder's glue. A fpecies of glue, ufed by painters, &c. is prepared of the parings of glove-leather and parchment. In fhort, there is fcarce any animal, whofe tendons, griftles, nerves, and fkin—which is ftill better for the purpofe, may not be ufed in the preparation of thefe different forts of glue.

It is to be obferved on this head, that glues differ in confiftency, colour, tafte, fmell, and folubility. Some glues diffolve well enough in cold water; and others are only foluble in boiling water. The beft glue is tranfparent, of a yellow colour, inclining to brown, without fmell or tafte, and entirely foluble in water, in which it forms a vifcid fluid, of an uniform appearance, and which, when it dries, remains equally tranfparent and tenacious through all its parts.

Animal jelly differs from glue, properly fo called, only in being lefs confiftent and vifcid. The former of thefe fubftances is obtained chiefly from the white and foft parts of young animals: it is alfo found in their flefh, mufcles, fkin, and bones. Glue is only obtained from the older animals, whofe fibres are ftronger and drier. However, as thefe two matters exhibit the fame chemical properties; in the examination of them, on which we are entering, we fhall take, for our fpecimen, the jelly that is obtained from the cartilages or membranes of the calf.

This matter has, in its natural ftate, fcarce any fmell: its tafte is infipid. When diftilled on a water-bath, it
affords

affords an infipid, inodorous phlegm, liable to putrefaction. As it lofes its water, it takes the confiftency of glue, and, when thoroughly dry, is like horn. When expofed to a pretty ftrong heat, and to air at the fame time, it fwells, bubbles, and becomes liquid: it then becomes black, and exhales a copious fmoke, of a fœtid fmell: it does not take fire, unlefs when expofed to a violent heat; and even then, not readily. By diftillation in a retort, it affords an alkaline phlegm, an empyreumatic oil, and a little ammoniacal carbonate. It leaves a coal of confiderable bulk, which is not eafily incinerated, and contains muriate of foda and calcareous phofphate.

Jelly, expofed to an hot and humid atmofphere, firft becomes acid, and foon after putrefies.

Water diffolves it in any proportion. Acids diffolve it eafily, and alkalis ftill eafier. The nitric acid difengages azotic gas from it. Moft of thefe properties are nearly the fame with thofe of infipid vegetable mucilages; only, infipid vegetable mucilages neither afford ammoniac by fire, nor azotic gas by the nitric acid. But this animal jelly may poffibly owe thefe properties to a portion of albuminous matter, extracted by the water, at the fame time with the gelatinous fubftance, efpecially when either glue or jelly is prepared by a long and ftrong decoction.

The mufcles of animals confift of a parenchymatous cellular fubftance, which contains various humours, partly concrete, partly fluid. Thefe humours are compofed, 1. Of a red and white albuminous fluid: 2. Of a gelatinous mucilage: 3. Of a fweet oil, of the fame nature with fat: 4. Of a peculiar extractive fubftance: 5. Laftly, Of a faline matter, the nature of which is not very well known. As the analyfis of the flefh entire, which affords, in the water-bath, a vapid water, and, in the retort, an

alkaline

alkaline phlegm, empyreumatic oil, and ammoniacal car-
bonate, and leaves a coal that affords, by incineration, a
little fixed alkali, and fome muriate of foda or potafh,——
as this analyfis affords no fatisfactory information con-
cerning the nature of thefe different principles, recourfe
muft therefore be had to fome means for extracting thefe
fubftances unaltered, in order that we may be enabled to
examine their properties feparately.

To obtain and feparate thefe feveral fubftances, the
exiftence of which has been afcertained by M. Thouvenel,
various modes of operation may be adopted. That phy-
fician fqueezed out, in a prefs, the fluids contained in
the mufcular fponge; he coagulated the albuminous part
by the action of fire, and obtained the falt by evapora-
tion; he diffolved and feparated the gelatinous mucilage,
the falt, and the extract, with water; and by means of
alcohol, he took off the two latter of thefe principles un-
mixed with jelly. It is generally very difficult to fepa-
rate thefe different matters exactly; becaufe they are all
foluble in water, and alcohol diffolves, at the fame time,
both the faponaceous extract, and a part of the falt.
The procefs which fucceeds beft, feems to be that which
confifts in, firft, wafhing the flefh in cold water, which
carries off the colouring matter, with a part of the falt;
then digefting the refidue which remains after this wafh-
ing, in alcohol, which diffolves the extractive matter, and
a part of the falt; and, laftly, boiling the flefh in water,
after treating it with thefe two proceffes. This fluid dif-
folves the gelatinous part by ebullition; and likewife
carries off fuch portions of the extract and the falt, as
have efcaped the action of the former folvents. A flow
evaporation of the firft water that was employed, in the
cold, coagulates the albuminous part, which may then
be feparated by filtration; and from this filtrated liquor,

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the faline matter may be obtained by another flow eva-
poration. By evaporating the alcohol in the fame way,
the coloured extractive matter is obtained: And laftly,
decoction feparates the jelly and the fat oil, which then
fwim on the furface, and are fixed by cooling. After
the extraction of thefe feveral fubftances, nothing re-
mains but the fibrous tiffue: it is white, infipid, and
infoluble in water: as it burns, it fhrinks and contracts:
it affords a good deal of ammoniac and very fœtid oil in
the retort, and a good deal of azotic gas by the acid of
nitre. Laftly, it poffeffes all the properties of the fibrous
part of the blood. It appears, therefore, that the muf-
cular organ is the refervoir in which the vital functions
depofite the fibrous matter; which becomes concrete by
reft, and appears to be the focus, or bafis of that property
of animals, which is denominated *irritability* by phyfiolo-
gifts.

All that now remains to be done, in order that we may
gain an accurate knowledge of the flefh of animals, is,
to examine the properties of each of the fubftances of
which it confifts.

The albuminous matter, jelly, and fat fubftance, are
already known to us. The firft is precifely of the fame
nature with the albuminous matter of the blood: we may
obferve, that it is this fubftance, which, being coagulated
by the heat of the water in which meat is boiled for
foup, produces the froth which is fo carefully fkimmed
off. This froth is of a dirty, red-brown colour; for the
original red colour of the albuminous matter is altered
by the boiling heat. Jelly, obtained from flefh, gene-
rally caufes foup prepared with the flefh of young ani-
mals, to form into a tremulous mafs; for the flefh of
young animals contains much more of it than the flefh
of old animals: it is perfectly like that which compofes

the soft white parts of animals, the properties of which have been explained in the preceding article. The fat matter which forms the flat round drops that swim on the surface of soups or broths, and becomes solid by cooling, exhibits all the characteristic properties of grease. We have, therefore, nothing but the extractive matter, and the salt that is obtained in analysing the muscles, to examine.

The substance which M. Thouvenel calls *mucous extractive*, is soluble in water, and in alcohol : it has a discernible taste, whereas the jelly has none. When strongly concentrated, its taste becomes acrid and bitter : it has a peculiar aromatic smell, which is developed by fire. This is the substance which colours soups, and gives them the agreeable taste and smell by which they are distinguished. When they are too much evaporated, or when the proportion of the meat to the water is large, soups have then an high colour, and are more or less acrid in their taste. In short, the action of fire developes and improves the taste of this extractive matter, till it, at length, gives it the taste of sugar or caramel, as may be observed of the surface of the roasted meat, which is said to be *crisped.* When this extractive substance is evaporated to a dry consistency, and its properties still farther examined, its taste is observed to be acrid, bitter, and saltish : when put on a burning coal in this state, it swells, and becomes liquid ; exhaling, at the same time, a pungent acid smell, like that of burnt sugar. If exposed to the air, it attracts moisture from it, and a saline efflorescence is formed on its surface : in an hot atmosphere, it becomes sour and putrid, if diluted in a certain quantity of water : and lastly, it is soluble in alcohol. These properties render this substance very nearly of the same

nature

nature with the faponaceous extracts, and the faccharine matter of vegetables.

As to the falt which is cryftallized in the flow evaporation of a decoction of flefh ; its nature is not yet perfectly known. M. Thouvenel obtained it in down, or in imperfectly-fhaped cryftals. That chemift thinks this to be a perfect neutral falt, confifting of potafh, and an acid which in frugivorous quadrupeds has the characteriftics of the phofphoric, and in carnivorous reptiles thofe of the muriatic acid. Although this falt may be confidered as unknown till fuch time as a fufficient quantity of it can be collected for a particular examination ; yet it is very probably either phofphate of foda, or ammoniacal phofphate ; and it may even be mixed with calcareous phofphate. Thefe falts are proved to exift here, and even with the fame excefs of acid as in urine, by the white precipitates which lime and ammoniac form in foup, as well as by the nitric folution of mercury producing from it a rofe-coloured precipitate.

We may add farther, that the fubftance the moft plentiful in mufcular flefh, and which peculiarly characterifes it, is the fibrous part. This matter is depofited from the blood, in which it exifts in a large proportion, and acts an important part in the functions of the animal œconomy. Phyfiologifts have not been particular enough in their accounts of its nature and properties, and of the weight and quantity of the flefh of the mufcles, in comparifon with that of the other organs. The properties which diftinguifh this animal matter, are, 1. Infolubility in water : 2. That of affording more azotic gas with the nitric acid than any other fubftance : 3. That of affording oxalic acid and malic acid, after the azotic gas : 4. That of becoming eafily putrid when moiftened, and affording a good deal of ammoniacal carbonate by diftillation.

Thefe

These properties shew, that it confists of a fat or oily fubstance, in combination with azote, of phofphate of foda, and of calcareous phofphate, which are feparated from it by the action of the nitric acid. I have confidered the office of the fibrous matter in the animal œconomy, in a particular Memoir, inferted among the Memoirs of the Royal Society of Medicine.

CHAP.

CHAP. XIII.

Of the Bones of Animals.

THE bones are the fupport of all the other parts of animals,—the bafis on which all the foft parts reft. Thefe hard parts are not to be confidered as paffive in the animal œconomy: they are actually fecretory organs, and feparate from the blood a peculiar faline matter, of which their own fubftance is formed, and which is defigned to be accumulated in them as refervoirs.

The bones, confidered as they exift in all animals, from man to the infect and the worm, differ in texture, in folidity, in pofition with refpect to the mufcles, and probably in the nature of their component principles. Chemical analyfis has not yet afcertained any thing concerning this laft particular. But one cannot help thinking, that the bones of men and quadrupeds muft be of a different nature from thofe of fifhes and reptiles, and ftill more different from the corneous fkeleton of infects, and from the calcareous covering of fhell-worms. The particular light in which we are here to examine the bones of animals, does not permit us to infift on thefe di-

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ftinctions; and chemifts have not yet made any refearches that can enable phyfiologifts to determine concerning them.

The bones of men and quadrupeds, the only bones that have yet been examined by chemifts, are not earthy matters, as was once thought. They contain a certain quantity of gelatinous matter difperfed through the fmall cavities which intervene between the folid plates of which their texture is compofed; and thofe folid plates, too, which, from their infolubility and confiftency, were taken for earthy matters, have been, within thefe few years, difcovered to confift of a true neutral falt, the component principles of which are phofphoric acid and lime.

Bones, when expofed to fire, with concourfe of air, kindle, in confequence of their containing a certain quantity of medullary fat. When diftilled in a retort, they afford an alkaline phlegm, a fœtid empyreumatic oil, and a confiderable proportion of ammoniacal carbonate. The coal which they leave is compact, and fomewhat difficult to incinerate. It leaves a white refidue, which, when wafhed in cold water, affords a fmall quantity of carbonate of foda. Hot water then feparates from it a certain quantity of fulphate of lime. What remains after thefe lixiviations, is not foluble in water: it is the calcareous phofphate which Dr Gahn of Stockholm difcovered, in the year 1769, to exift in bones. Bones calcined in the focus of a furnace, among coals, remain luminous in the dark: when urged with a very violent heat, they are half-vitrified, and thus reduced to a fort of hard porcelain, very white, and femi-tranfparent.

The water in which bones grated down are boiled, is charged with a fubftance which renders it vifcid, and is a true gelatinous matter.

<div align="right">Alkaline</div>

Alkaline carbonates are capable of decompofing the calcareous phofphate which forms the bafis of bones. This decompofition is mentioned by the chemifts of the Academy of Dijon: they fay, that they effected it on treating, by fufion, a mixture of powder of calcined bones, and carbonate of potafh.

Acids act upon bones, and decompofe the calcareous phofphate contained in them. It was by this means that Scheele, in the year 1771, prepared phofphorus from bones. He diffolved the bones in nitric acid. The acid feizing the lime contained in them, formed with it calcareous nitrate, which remained in folution, while the phofphoric acid was difengaged. Into this mixture he poured fulphuric acid, which, by detaching the lime from the calcareous nitrate, formed fulphate of lime: this fulphate of lime being precipitated as infoluble, he feparated it by filtrating the liquor. Laftly, he diftilled in a retort the filtrated liquor, which was a mixture of nitric acid and phofphoric acid; and after evaporating it to the confiftency of a fyrup, heated it with coal, in order to obtain from it phofphorus. Meffrs Poulletier de Salle and Macquer were the firft who repeated thefe ingenious experiments at Paris. After that, the academicians of Dijon, M. Rouelle, M. Prouft, and M. Nicolas de Nancy, communicated their refearches and proceffes, on the fame matters, to the public. Various other chemifts have vied with thefe in examining the different folid matters of animal bodies. Among others, M. Berniard has obtained phofphoric acid from foffil bones, from whale-bones; from the bones of the elephant and the porpoife, from thofe of the elk, from thofe of the cow, from human bones; from the teeth of the fea-cow, and from the grinders of the elephant; and he has obferved, that all thefe bones afford the fame fubftances,

and

and contain phofphoric acid in various proportions. The Marquis de Bullion has alfo obtained phofphoric glafs from ivory, and from the bones of fifhes.

The procefs moftly followed at prefent, in extracting phofphoric acid from bones, is that of the chemifts of Dijon, and M. Nicolas. The bones are burnt white, reduced to powder, and paffed through a fieve : they are then mixed, in a veffel of ftone-ware, with an equal quantity of concentrated fulphuric acid, and as much water is added as is fufficient to give the whole the confiftency of clear foup : the mixture is now fuffered to reft for fome hours, in the courfe of which it becomes thick ; it is then poured on a filter of double cloth, and wafhed with water till the fluid pafs through clear, and without acquiring any tafte, or the property of precipitating lime-water. It is then certain, that the refidue contains no naked phofphoric acid : the water which has been ufed in the wafhings is now evaporated ; it depofites, by degrees, a white matter, which is fulphate of lime, and muft be feparated by the filter.

This falt muft be carefully wafhed, in order to carry off all the phofphoric acid : thefe filtrations are to be repeated till the liquor ceafe to afford any fediment. The evaporation muft be continued till it acquire the confiftency of honey, or a foft extract. Its colour is then brown, and its appearance greafy. It is next put into a crucible, and heated till it ceafe to exhale a fulphureous and fomewhat aromatic fmell which at firft arifes from it,—and till it ceafe to bubble. In this ftate, the confiftency of this matter is half vitreous, and its tafte acid : it attracts moifture from the atmofphere. If urged farther with heat, it melts into a tranfparent glafs, which is hard, infipid, and infoluble, and exhibits no mark of acidity. To obtain phofphorus from it, there

is

is no occafion for waiting till this refidue of the acid li-
quor, after evaporation, be brought into the ftate of an
infoluble glafs. In that ftate greater ftrength of fire is
requifite; and even with that it yields phofphorus much
flower than when foft and deliquefcent. To reduce
this glafs into phofphorus, it muft firft be brayed to
powder; then mixed with a quantity of dry charcoal,
equal to one third of its own weight; next put into a
ftone retort, with a balloon half full of water fitted to it,
which balloon muft be pierced with a fmall hole, or con-
nected by a fyphon with Woulfe's apparatus. Fire is to
be gradually applied till the retort be firft reddened, and
then rendered white; the phofphorus then runs in drops;
and the operation lafts, altogether, from feven or eight,
to ten or twelve hours, according to the quantity of the
matter that is diftilled, and the degree of heat which
the furnace is able to bear. Six pounds of bones ufual-
ly afford twenty ounces, or fomewhat more, of a vitreous
refidue; and that refidue affords about three ounces of
very fine phofphorus, and a few drachms of phofphorus
half decompofed. When the defign is to prepare phof-
phorus of the phofphoric acid of bones, the acid muft be
evaporated to the confiftency of an extract, and diftilled
with coal. Phofphorus is much more readily obtained
by this procefs than by any other.

The cafe is the fame with the acid product obtained
from bones by the action of the fulphuric acid, as with
the refidue of ammoniacal phofphate decompofed by fire.
That product is not pure phofphoric acid; for it never
affords more than one fifth of its weight of phofphorus:
it feems to contain a certain quantity of phofphate of
foda. When this falt is mixed with calcareous phofphate
produced from a little fulphate of lime, it ufually
melts with that phofphate, and forms with it a very

hard

hard opaque glafs, which refifts the action of all menftrua.

M. de Morveau has propofed a méthod for obtaining very pure ammoniacal phofphate from the phofphoric acid of bones. In order to that, diffolve the bones, after calcination, in weak fulphuric acid; affay the folution with a folution of bones in the nitric acid, in order to afcertain whether there ftill remain in it any fulphuric acid in a naked ftate: then precipitate, by cauftic ammoniac, the calcareous phofphate which it contains,— as has been done by M. Wiegleb, in his procefs: filtrate the liquor; and leave it to evaporate in the open air. You thus obtain very beautiful cryftals of ammoniacal phofphate, mixed with a little phofphate of foda which feparates by efflorefcence: the calcareous phofphate remaining on the filter may be likewife decompofed, in order to form phofphorus from it.

C H A P.

C H A P. XIV.

Of various Subſtances of Uſe in Medicine and the
Arts, which are obtained from Quadrupeds, the
Cetaceous Animals, Birds, and Fiſhes.

WERE my deſign to give a minute and accurate
hiſtory of all the animal ſubſtances uſed in me-
dicine and the arts, I ſhould have occaſion to ſay more
on this ſingle head, than I have hitherto ſaid concerning
the whole animal kingdom; eſpecially when I ſhould
come to mention the different animal matters that were
formerly introduced into medicine, by quackery or cre-
dulity, as famous ſpecifics, and are now happily conſider-
ed as entirely uſeleſs. I intend only to mention the
principal of thoſe ſubſtances,— ſuch as chemical and
medical experience has determined to poſſeſs powerful
virtues, and ſuch as are at preſent much uſed in the
arts.

Of the matters which quadrupeds afford, we ſhall con-
ſider only caſtoreum, muſk, and the hart's-horn. The
white of the whale, and ambergriſe, are the only pro-
ducts

ducts of cetaceous animals which will be here treated of. Of the products of birds, we ſhall give an analyſis of the egg. .Among oviparous quadrupeds and ſerpents, the tortoiſe, the frog, and the viper, will deſerve to be ſeparately conſidered. The only product of fiſhes which we ſhall examine, is the ichthyocolla. Inſects will afford numerous ſubjects for examination: we ſhall conſider cantharides, ants, wood-lice, honey and wax, ſilk and the ſilk-worm, gum lac, kermes, cochineal, and crabs ſtones. Laſtly, we ſhall cloſe our examination of the products of the animal kingdom, with conſidering the nature of the coral and corallines, which belong to the claſs of worms or polypi.

From this brief enumeration of the matters which we mean here to conſider, it will appear, that we mean to take no notice of a great many other animal matters which were formerly uſed in medicine ; ſuch as, among others, ivory, the unicorn's horn, the teeth of the hippopotamus, of the beaver, and of the boar, the bones of the ſtag's heart, the feet of the elk, bezoar, civet, and the blood of the wild goat, among quadrupeds ; the ſwallow's neſt, gooſe greaſe, peacock's dung, and the membrane of the ſtomach of poultry, among birds ; the toad and the ſcincus, among oviparous quadrupeds ; the gall and ſtones of the carp, the liver of the eel, the ſtones of the perch, and the jaws of the pike, among fiſhes ; the ſcarabæus, the ſpider's web, the meloe or proſcarabæus, and the claws of the crab, among inſects; laſtly, ſhell-worms, ſnails, oyſter-ſhells, nacres of pearls, and bones of cuttle fiſh, among the naked or covered worms. Of theſe ſubſtances, ſome poſſeſs none but imaginary virtues ; and the uſes of others are better ſupplied by the ſubſtances which we have ſelected for examination.

§ I.   *Of*

§ I. *Of Caftoreum.*

THE name of *Caftoreum* is given to two bags fituated in the inguinal region of the male or female beaver, containing a ftrongly odorous matter, which, when they are newly taken from the animal, is foft and almoft fluid, but in the courfe of time becomes dry, and acquires the confiftency of a refin. This matter has an acrid, bitter, and naufeous tafte; its fmell is ftrong, aromatic, and even fœtid: it confifts of a coloured refin, foluble by alcohol and æther; a gelatinous, and partly extractive mucilage, which are taken up by water; and a falt, which cryftallizes when the aqueous folution is evaporated, but of which the nature is not yet known. The refin of caftoreum, in which all its virtue confifts, feems to be very nearly of the fame nature with that of the bile. The whole of this animal product is included in membranous cells which proceed from the internal tunic of the bag in which they are contained. Caftoreum has never been yet properly analyfed: we know only that it affords a little volatile oil, and fome ammoniacal carbonate, by diftillation; and that, by means of æther, alcohol, and water, the feveral matters of which it confifts may be feparated.

It is ufed in medicine as an antifpafmodic, in hyfteric and hypocondriac cafes, and in the convulfions occafioned by thofe affections. It often produces the happieft effects very fpeedily; but at other times it irritates, inftead of foothing; its effects being either favourable or unfavourable, according to the particular character of the nervous fyftem of the patient. It ought therefore to be adminiftered only in fmall dofes, when it is firft given. It has been alfo prefcribed with fuccefs for the epilepfy

and

and tetanus. It is ufually given in dofes of from a few grains to half a drachm; it enters into the compofition of boles; it is generally, and almoft always with good effects mixed with opium, and all calming or narcotic extracts. It is likewife ufed in a fpiritous and an æthereal tincture, of which, from a few drops to four-and-twenty or fix-and-thirty grains are given in certain drinks.

§ II. *Of Musk.*

MUSK, a fubftance of which the ftrong and permanent fmell is generally known, is contained in a bag fituated near the umbilical region of a ruminating quadruped fo like the antelope, that it fcarce deferves to be ranked under a different genus. This matter, in its chemical properties, refembles caftoreum. It is a refin, combined with a certain quantity of mucilage, bitter extract, and falt. Factitious mufk is often fold inftead of the real. Its virtues are fuperior to thofe of caftoreum: it is more active; and is therefore never employed but in cafes of extreme urgency. It is given as a potent antifpafmodic, in convulfive diforders, in the hydrophobia, &c. It is likewife confidered as a violent aphrodifiac. It fhould be very cautioufly ufed; for it often excites, inftead of allaying nervous affections.

§ III. *Of Hartshorn.*

HARTSHORN is one of thofe animal fubftances which are the moft ufed in medicine. It is a bony fubftance, and does not in any refpect differ from bones. It contains a confiderable quantity of foft jelly, very light and

and nourifhing, which is extracted by boiling it, after it has been firft reduced into fmall pieces, in eight or ten times its own weight of water. By diftillation in a retort, it affords a reddifh ammoniacal phlegm called *volatile fpirit of hartfhorn*, an oil more or lefs empyreumatic, and a great quantity of ammoniacal carbonate contaminated with a little oil. There is difengaged from it a very large proportion of elaftic fluid, confifting of a mixture of carbonic acid gas, azotic gas, and hydrogenous gas with carbonaceous matter and even volate oil diffolved in it. The oil, however, is gradually precipitated by cooling; it then adheres to the fides of the glafs veffels containing the elaftic fluid. As the volatile falt is coloured, it muft be digefted in a little alcohol, to free it of the oil by which it is contaminated. The carbonaceous refidue, when incinerated, is found to contain a little carbonate of foda, fome fulphate of lime, and a confiderable quantity of calcareous phofphate mixed with phofphate of foda—which, as has been mentioned in the article of bones, is to be decompofed with fulphuric acid.

The fpirit and falt of hartfhorn are ufed in medicine, as good antifpafmodics. The former, faturated with fuccinic acid, forms the fuccinated liquor of hartfhorn.

Oil of hartfhorn, when rectified by a gentle heat, becomes very white, ftrongly odorous, highly volatile, and almoft as inflammable as æther. It is known by the name of *animal falt of Dippel*, a German chemift, who was the firft that prepared it. It ufed formerly to be rectified a great many times, in order to render it very white and fluid. But it has fince been obferved, that two or three diftillations are fufficient, provided care be taken, 1. To introduce the oil that is to be rectified, into the retort, through a long funnel, in order that the neck
of

of the veſſel may be very clean ; for, a ſingle drop of coloured oil would be enough to colour the whole quantity under diſtillation : and, 2. To take only the firſt portions, which are the whiteſt, and the moſt volatile. For theſe obſervations, we are indebted to Meſſrs Model and Baumé.—Rouelle has likewiſe given a very good proceſs for obtaining this oil ; it conſiſts in diſtilling it with water. As none but the·moſt volatile part, which is truly æthereal, and entirely contained even in the oil of the firſt diſtillation, can be volatilized. by the heat of boiling water, we are ſure of obtaining, by this mode of operation, nothing but the moſt ſubtle and penetrating part. This oil has a lively ſmell, and is amazingly light and volatile : it exhibits all the properties of vegetable volatile oils ; and ſeems to differ from them only in containing ſome ammoniac ; for, it turns ſyrup of violets green, as has been obſerved by M. Parmentier. This oil is uſed, in drops, in caſes in which the nerves are affected, in the epilepſy, &c.

§ IV. *Of the White of the Whale.*

THE white of the whale, improperly called *ſperma ceti*, is an oily matter, concrete, cryſtalline, ſemi-tranſparent, and of a peculiar ſmell, which is taken from the cavity of the cachalot, and is purified by liquefaction, and by the ſeparation of another oil, fluid, and not ſuſceptible of concretion, which is mixed with it. This ſubſtance diſplays very ſingular chemical properties, in which it nearly reſembles both fixed and volatile oils.

The white of the whale, when heated in·contact with air, kindles, and burns in an uniform manner, without diffuſing any diſagreeable ſmell. Excellent candles are
                                            therefore

therefore made of it, in thofe places where it is prepared, at Bayonne, at St Jean-de-Luz, &c. In England, there are many manufactories of thefe candles: within thefe few years, fome fuch have been eftablifhed at Paris.

When diftilled by naked fire, it does not, according to M. Thouvenel, yield any acid phlegm, like fixed oils, but paffes entire, and almoft unaltered, into the receiver, as foon as it begins to boil; leaving on the retort a carbonaceous mark. On repeating the operation, it lofes its folid form, and remains fluid, without becoming more volatile.

The white of the whale, when expofed to hot air, becomes yellow and rancid, but not fo eafily as other fixed concrete oils. Water in which it has been boiled, affords, by evaporation, nothing but a light mucofo-unctuous refidue.

Cauftic alkali diffolves the white of the whale, and forms with it a foap which, by degrees, becomes folid, and at length friable.

The nitric and the muriatic acids are incapable of acting on this fubftance. The concentrated fulphuric acid diffolves it, and, at the fame time, alters its colour: this folution is precipitated by water, like oil of camphor.

The white of the whale combines with fulphur, like fixed oils.

Fixed and volatile oils diffolve the white of the whale, with the help of heat. Hot alcohol likewife diffolves it, but fuffers it to precipitate by cooling. Æther effects this folution cold, or, at leaft, without the help of a greater heat than the natural warmth of the hand.

Perhaps, the white of the whale may bear the fame relation to fixed oils which camphor bears to volatile oils.

It

It differs effentially from wax, which feems to bear the fame relation to the former, as refin to the latter.

Formerly, this fubftance was very much ufed in medicine ; a great variety of medicinal properties were afcribed to it. It was ufed, efpecially, in cafes of catarrh, erofions, ulcers of the lungs and reins, &c. At prefent, it is employed as a calming medicine; and, even for that purpofe, in very fmall dozes, and mixed with mucilages; for it is allowed to be heavy upon the ftomach, and to occafion difguft, naufea, and even vomiting.

1 have found, in animal matters, efpecially in the parenchyma of the liver, after drying it in the air for fome years, and in the mufcles of animals altered by putrefaction, a matter poffeffing nearly the fame properties with the white of the whale. This fubftance, therefore, appears to me to be very copious among animal matters, and to be an oil peculiar to this department of nature.

§ V. *Of Ambergrife.*

AMBERGRISE is a concrete matter, of a foft tenacious confiftency like wax, of a grey colour, marked with yellow or black fpots, and of a ftrong, fweet fmell, when it is heated or rubbed. It exifts in irregular maffes, which are fometimes round, and confift of layers of different forts, and either greater or fmaller, according as the number united in the mafs is greater or lefs. There have been pieces of it feen, which weighed more than two hundred pounds. This fubftance appears evidently to have once been in a liquid ftate, as various extraneous matters are found incorporated with it ; fuch as the neb of the cuttle fifh, bones of fifhes, and other marine bodies. Ambergrife is found floating on the waters of the
ocean

ocean near the Molucca Ifles, Madagafcar, Sumatra, and on the coafts of Coromandel, Brazil, Africa, China, and Japan. Some American fifhermen informed Dr Schwediaur, an Englifh phyfician, that they had often feen this matter among the excrements of that fpecies of the whale which Linnæus calls *phyfeter macrocephalus*, in his ftomach, and in a bag fituated near that region. Naturalifts take notice of a good many varieties of ambergrife. Wallerius reckons the fix that follow :

Varieties :

    1. Grey ambergrife, with yellow fpots.

    2. Grey ambergrife, with black fpots.

        Thefe two varieties are the moft valuable, and the moft in requeft.

    3. White ambergrife, of only one colour.

    4. Yellow ambergrife, of no more but one colour.

    5. Brown ambergrife, of a fingle colour.

    6. Black ambergrife of a fingle colour.

It is to be obferved, that thefe varieties are owing to a mixture of fome extraneous fubftances.

There is a great difagreement among philofophers concerning the origin of ambergrife. By moft of them, it has been confidered as a bitumen,—a fort of petroleum, iffuing from the rocks, and condenfed by the action of the fun and the water of the fea. Others have imagined it to be made up of the excrements of birds nourifhed on odoriferous herbs. Others, again, have afcribed its origin to the foam of the fea, the excrements of the crocodile, &c. Pommet and Lemery thought it a mixture of wax and honey, hardened by the action of the fun, and altered by the fea-water. M. Formey, who has adopted this

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opinion, fupports it by an experiment which confifts in digefting wax and honey. He afferts, that a product may thus be formed, of an agreeable fmell, nearly the fame with that of ambergrife.—Some Englifh authors have confidered ambergrife as an animal juice, depofited in bags fituated near the root of the genital organ in the male whale; and others have imagined, that it is formed in the bladder of that cetaceous animal: But the nebs of cuttle-fifhes found in this concrete juice, are fufficient to confute thefe opinions. Laftly, Dr Schwediaur, after examining a great many fpecimens of ambergrife, and receiving accounts concerning it from different navigators, has concluded this fubftance to be formed in the alimentary canal of the *phyfeter macrocephalus*,—the fpecies which affords the *fperma ceti*, or white of the whale. He confiders ambergrife as an excrement of this cetaceous animal, mixed with fome parts of its food,—1. Becaufe fifhermen find it in this whale: 2. Becaufe it is common in the latitudes which they inhabit: 3. Becaufe beaks of the cuttle-fifh with eight feet, *fepia octopoda*, on which that animal lives, are always found in it: 4. Laftly, Becaufe he diftinguifhed the black fpots mixed through ambergrife to be the feet of this polypous animal. His refearches have raifed this opinion of the Japanefe, and of Kempfer, to an high degree of probability; for which reafon, we now rank this matter among the products of the animal kingdom.

Yet this fubftance, which has been analyfed by Geoffroy, Neuman, Grim, and Brown, afforded thofe chemifts the fame principles with bitumens; that is to fay, an acid fpirit, a concrete acid falt, fome oil, and a carbonaceous refidue. But Dr Schwediaur obferves, with great propriety, that the calculi of the animals afford the acid, and that the exiftence of that falt is in favour of his opinion, for fats contain a great deal of it.

Amber-

Ambergrife is ftomachic, cordial, antifpafmodic. It is ufed in dofes of feveral grains, in certain drinks, or mixed with other fubftances, in pills. The odorous principle of this medicine is often too active, too penetrating, and liable to do harm. It is well known, that many perfons cannot bear the fmell of it without feeling their nerves very difagreeably affected : it fhould therefore be adminiftered very cautioufly. It has been alfo confidered as a powerful aphrodifiac. Some phyficians, however, think that ambergrife may be prefcribed in very copious dofes, without producing any very powerful effects.

Ambergrife is chiefly ufed as an article of perfume, for the toilet : it is ufually mixed with mufk, the fmell of which it weakens fo as to render it much more agreeable. Yet every perfon is not fond even of this mixture.

As ambergrife is very dear, it is counterfeited and mixed with different fubftances. When genuine, it difplays the following properties : It is fcaly, infipid, and fweet-fmelling ; it melts without rifing in bubbles or froth, when expofed, in a filver-fpoon, to the flame of a taper; it fwims on water, and does not ftick to hot iron. Ambergrife which does not exhibit thefe properties, is to be confidered as impure.

§ VI. *Of the Eggs of Birds.*

BIRDS' eggs, particularly hen-eggs, confift, 1. Of a bony fhell, which has been fhewn by M. Berniard, to contain a jelly, and calcareous phofphate ; 2. Of a membranous pellicle, immediately under the fhell, which appears to be a tiffue of fibrous matter ; 3. Of white ;

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4. Of

4. Of yellow, inclofed and fufpended in the middle of the white. On this laft fubftance the germ is fupported.

The white of the egg is precifely of the fame nature with the ferum of the blood : it is vifcid and adhefive : it communicates a green colour to fyrup of violets; and contains carbonate of foda, in a naked ftate. By a gentle heat, it is coagulated into an opaque, white mafs, which exhales the fœtid fmell of fulphurated or hepatic hydrogenous gas. This white, when coagulated and dried on a water-bath, affords an infipid phlegm, which putrefies, and acquires the drynefs and reddifh tranfparency of horn. By diftillation in a retort, it affords ammoniacal carbonate, and empyreumatic oil: its coal contains foda, and a little calcareous phofphate. M. Deyeux likewife obtained a little fulphur from it, by fublimation.

The white of the egg, when expofed to the air in thin layers, rather becomes dry than putrid, and forms a fort of tranfparent varnifh. It diffolves in water in any proportion. Acids coagulate it : This coagulum, when diluted in water and filtered, affords, by evaporation of the filtered liquor, a neutral falt, confifting of the acid which was employed to effect the evaporation, with foda. Alcohol likewife coagulates the white of the egg. Lime-water precipitates calcareous phofphate from it ; and nitrate of mercury produces phofphate of mercury, which takes a rofe-colour by deficcation.

The yellow, or yolk of the egg, confifts moftly of albuminous matter, mixed, however, with a certain quantity of fweet oil ; fo that this mixture diffolves in water, and forms a fort of animal emulfion called *hen's milk.* When expofed to the action of fire, it is reduced to a mafs, not fo folid as that which the fame agent

forms

forms from the white. When dried, it becomes foft, in confequence of the difengagement of its oil, which exfudes from its furface. By fubmitting it to the prefs, in this ftate, that oil is obtained, and is found to be fweet and fat, and of a fmell and tafte, in a flight degree, empyreumatic. The yolk of the egg diftilled, after the extraction of this oil, affords the fame products as other animal matters. Acids and alcohol coagulate it. The eggs of animals, as containing fweet oil, bear a great refemblance to the feeds of many vegetables; for thefe likewife contain a fweet oil, united in the fame manner with a mucilage, and reduced to an emulfive ftate.

Eggs are very much ufed as an article of food. Their different parts are ufed in pharmacy and medicine. The fhell is calcined, and employed as an abforbent. It is applied externally, to cure burnings, chaps, &c. The yolk of the egg renders oils foluble in water, and thus forms lohochs : it is triturated with refins, camphor, &c. The white of the egg is of confiderable ufe in pharmacy and confectionary, to clarify the juices of plants, wheys, fyrups, and other fluids. It is alfo laid on paintings, which it preferves by forming a tranfparent varnifh on their furface.

§ VII. *Of Ichthyocolla.*

ICHTHYOCOLLA, or fifh-glue, is a fubftance partly gelatinous, partly lymphatic, which is prepared by rolling up the membranes that form the air-bladder of the fturgeon, and fome other fifhes, and leaving them to dry in the air, after twifting them into the form of a fhort cord,—in which we receive them. This matter affords a vifcous jelly, when boiled in water. When left

to macerate in that fluid, it may be unfolded and ex-
tended into a fort of membrane. It is never brittle, like
glues properly fo called ; but its fibrous and elaſtic tex-
ture renders it always fuſceptible of being twiſted.
There is alfo a fpecies of it prepared from a decoction of
the ſkin, the ſtomach, and the inteſtines of fiſhes ; but
this fpecies is not equally valuable in the arts. All the
products of other animal fubſtances are obtained
from ichthyocolla. It may be employed in medi-
cine, as an emollient, in diforders affecting the throat,
the inteſtines, &c. ; but feveral vegetable fubſtances,
poffeffing the fame virtues, are commonly preferred. It
is ufed in the arts, to clarify liquors, wine, cof-
fee, &c. It attracts and precipitates all extraneous mat-
ters, altering their tranfparency.

§ VIII. *Of the Tortoife, the Frog, and the Viper.*

THE tortoife, the frog, the lizard, and the viper, are
very much ufed in medicine : decoctions or foups, to
which peculiar virtues have been afcribed, are pre-
pared of them. In fact, animals whofe component parts,
in general, are ſtrong-fmelling, and are found to con-
tain a good deal of faline matter, by affording a confi-
derable quantity of ammoniac, when diſtilled by a gen-
tle heat after being triturated with potaſh ;—it would
appear, that fuch animals muſt poffefs more nume-
rous and more powerful virtues than others. Many
phyficians, however, doubt of the fingularity of their
virtues, and clafs them with other animals. Notwith-
ſtanding this opinion, turtle and frog foups are ſtill ad-
miniſtered in difeafes attended with languor, in confump-
tions without apparent caufe, and in recovery from acute
difeafes,—

difeafes,—and are often attended with good effects. It appears, that decoctions of thefe animal fubftances are peculiarly nourifhing, light, and pleafant, and perhaps, at the fame time, poffeffed of a peculiar activity, as their ftrong fmell and uncommon tafte feem to indicate. Within thefe few years, the ufe of green lizards has been recommended in diforders affecting the fkin, and cancers; but we may venture to doubt of their virtues.

Vipers are thought peculiarly active. The ancients talked much of their virtues in diforders affecting the fkin, in diforders of the breaft, and in chronical diftempers in which the lymph is vitiated. One cannot help thinking, that viper foups muft occafion depuration by the fkin, by virtue of their powerful aroma. The powder and volatile falt of thefe animals is far from poffeffing the fame virtues. To produce their full effects, thefe animals fhould be adminiftered altogether as articles of food in the above difeafes.

M. Thouvenel obtained from thefe animals, by chemical analyfis, a jelly more or lefs light, either confiftent or vifcid,—an acrid extract, bitter and deliquefcent,—a concrefcible albuminous matter,—an ammoniacal falt,—and an oily fubftance, of a peculiar tafte and fmell, and fometimes foluble in alcohol, &c.

§ IX. *Of Cantharides.*

CANTHARIDES, a medicine fo valuable for its corrofive and epifpaftic powers, confift, according to M. Thouvenel, 1. Of a parenchyma, the nature of which he has not determined, and which compofes one half of the weight of the dried infect: 2. Of three

drachms

drachms to the ounce of a reddish-yellow extractive matter, exceedingly bitter, which affords acid by distillation : 3. Of twelve grains to the ounce of a yellow, wax-like matter, to which the golden yellow colour of cantharides is owing : 4. Of sixty grains of a green, oily, wax-like substance, of an acrid taste, in which the smell of cantharides chiefly resides. This substance affords, by distillation, a very pungent acid, and a concrete, wax-like oil. Water dissolves the extract, the yellow oil, and even a little of the green oil ; but æther does not act on the latter, and may therefore be successfully employed to separate the others. The virtue of cantharides is owing to this green wax. To extract this, together with the extractive matter, and by such means form a tincture charged with the substance of these insects, a mixture consisting of equal parts of alcohol and water, must be employed. When this mixed tincture is distilled, the alcohol retains a faint smell of cantharides ; and the several matters contained in it are separated, as the evaporation takes place.

§ X. *Of Ants and the Formic Acid.*

THE acid of ants has been observed by Tragus, Bauhin, and several other botanists, who perceived the flower of chicory to become very red in an ant-hill. Samuel Fisher, Etmuller, and Hoffman, successively examined it. Margraf examined it with great care, and found that ants contain a peculiar acid, a fixed oil, and an extract. Messrs Ardwisson and Oerhne have made the most complete series of experiments on this acid.

This acid is obtained, especially from the great red ant, *formica rufa,* either by distillation in a retort, or by

lixiviation with boiling water. This acid, when rectified, and a little concentrated, has a pungent smell: it is burning: its taste is pleasant, when diluted with a large proportion of water; it has therefore been proposed as a seasoning, instead of vinegar. It speedily reddens all blue vegetable colours: it is decomposed by fire, which converts one part of its principles into carbonic acid; and by the sulphuric and the nitric acids, which also extricate from it the same acid. It detaches oxigene from the oxigenated muriatic acid: it is stronger than the sulphuric, the boracic, the carbonic, the acetous, or the nitrous acid. It forms a sort of æther with alcohol. The neutral salts which it forms with alkaline bases, have been examined by Messrs Ardwisson and Oerhne. Formiate of potash has been prepared by M. Thouvenel, by spreading cloths, previously dipped in potash, over ant-hills which had been opened up: the ants running upon the cloths, deposited upon them as much of their acid, and of the odorate principle which they exhale in great abundance, as was sufficient to saturate the fixed alkali. A lixivium formed from those cloths, afforded, by evaporation, a neutral salt in flattened parallelograms, or prismatic columns, and not deliquescent.

Lime forms, with this acid, a crystallizable and soluble salt. In a word, modern chemists consider the formic as a peculiar acid. Its affinities have been arranged in the following order, by Messrs Ardwisson and Oerhne: barytes, potash, soda, lime, magnesia, ammoniac, zink, manganese, iron, lead, tin, cobalt, copper, nickel, bismuth, silver, aluminous earth.

Alcohol digested over ants, extracts from them a little volatile oil, which, with that fluid, forms Hoffman's *spirit of magnanimity*. By first boiling these insects in water, and then squeezing them, a fixed oil is obtained in the

proportion

proportion of thirteen drachms to the pound. This oil
is of a greenifh yellow colour: it congeals fooner than
oil of olives, and is much like wax. The water of the
decoction affords, by evaporation, a reddifh brown ex-
tract, of a fœtid fmell, acidulous and cafeous, of a bitter
tafte, naufeous and acid. This extract is feparable into
two fubftances, by the fucceffive application of water
and alcohol.' The parenchyma of ants feparated from
thefe fubftances, amounts to two or three drachms in
the pound.

§ XI.   *Of Wood-Lice.*

WOOD - LICE, *millepedes, afelli, porcelli, onifci,* &c.
exhibited to M. Thouvenel, when he analyfed them,
fome properties peculiar to themfelves. When diftilled
without addition, in a water-bath, they afforded an infipid
alkaline phlegm, which fometimes produced an effer-
vefcence with acids, and turned fyrup of violets green.
They loft, in this operation, five eighths of their weight.
When treated, afterwards, with water and alcohol, they
afforded two drachms of foluble matter in the ounce;
and of thefe, more than two thirds was extractive matter,
and the reft an oily or wax-like fubftance. Thefe two
products are eafily feparable by æther, which diffolves,
the latter, without affecting the former. Thefe matters,
differ from thofe of cantharides and ants, in affording
more ammoniacal carbonate, and no acid, when diftilled.
M. Thouvenel obferves, on this fubject, that, among
infects, wood-lice feem to bear the fame relation to can-
tharides and ants, as oviparous quadrupeds and ferpents
bear to viviparous or real quadrupeds.

As to the neutral falts contained in thefe infects, their quantity is exceedingly fmall, and it is no eafy matter to extract them. M. Thouvenel afferts, that wood-lice and earth-worms, *lumbrici,* always afforded him calcareous muriate, and muriate of potafh ; whereas, in ants and cantharides, thefe two bafes, of which the laft always appeared to be the moft copious, were always combined with an acid poffeffing the fame properties as the phofphoric acid. It is to be obferved, that this chemift has not explained, in his differtation, the methods by which he extracted thefe falts, or the proceffes by which he afcertained their nature.

Only cantharides and wood-lice are made ufe of, in medicine. Wood-lice appear to act only as gentle ftimulants and diuretics ; and, according to M. Thouvenel's experiments, fhould be given in ftill ftronger dozes than are commonly prefcribed of them. The juice expreffed from forty or fifty living wood-lice, given in a mild drink, or mixed with the juice of fome aperient plants, may be given, with happy effects, in the jaundice, ferous diforders, *à ferofa colluvie,* and coagulations of the milk, &c. Cantharides is one of the moft potent of all medicines. M. Thouvenel himfelf had experience of the effects of the green waxen matter in which the virtues of thefe infects feem to refide : nine grains of it laid on the fkin, raifed a blifter, full of ferous matter, in the fame manner as powder of cantharides. But what is moft particularly worthy of notice of all the facts refpecting the virtues of this powerful remedy, is, that the fpiritous tincture of cantharides may be applied, with the happieft fuccefs, externally, in dozes of from two drachms to two ounces and an half, in rheumatic and fciatic pains, and in the wandering gout. It heats the fkin, quickens circulation, and occafions evacuation by fweat, urine, and ftool, according

cording as it is applied on this or that part. Young phyſicians are to be cautioned againſt adminiſtering this medicine too raſhly, internally : It has been known to occaſion fluſhings on the ſkin, ſweating of blood, pains in the loins and bladder, dyſenteries, &c.

§ XII.   *Of Honey and Wax.*

THE honey and wax prepared by bees, appear to be-long to the vegetable kingdom ; for theſe inſects collect the one of theſe ſubſtances from the nectaria of flowers, the other from the antheræ of their ſtamina. But they are elaborated in a particular manner : and be-ſides, as they are the work of bees, their properties come moſt naturally to be examined in the hiſtory of theſe inſects.

Honey is a matter perfectly like the ſaccharine juices which we have examined as belonging to vegetables. Its colour is white or yellowiſh ; its conſiſtency ſome-times ſyrupous, often ſoft and granulated, and its taſte ſaccharine and aromatic.   By alcohol, and even by wa-ter, with a little trouble, a real ſugar may be obtained from honey.   It affords, in the retort, an acid phlegm, and an oil ; and its reſidual coal is ſpongy and porous, like that of the mucilages of plants.   The nitric acid converts honey, as well as ſugar, into oxalic acid.   It diſſolves very eaſily in water : it forms a ſyrup, and paſſes, like ſugar, in the ſtate of ſpiritous fermentation. It is a very agreeable article of food, and a ſoftening, and ſlightly aperient medicine.   Diſſolved in water, and mixed with vinegar, under the name of oxymel ;—it is frequently combined with ſome acrid plants, as in oxy-mel of ſquills, and of colchicus.   It is the vehicle in
many

many medicines which bear its name, fuch as honey of rofes, honey of water-lily, mercuriai honey, &c.

Wax is a concrete, oily juice, refembling folid fixed oils, fuch as butter of cacao, and ftill more like vegetable wax. Although there can be no doubt that this fub-ftance is collected from the ftamina of flowers, yet it is no lefs certain, that it undergoes fome particular ela-boration in the body of the animal; for Reaumur found it impoffible to form flexible wax of the powder of flowers. The wax which compofes the honey-combs of bees is yellow, and of an infipid tafte. The action of the dew and the atmofphere whitens it, when expofed to it in thin plates: the oxigenated muriatic acid whitens it very fpeedily. It becomes foft by a gentle heat, melts, and forms a tranfparent oily fluid: by cooling, it be-comes folid and opaque. When heated in contact with air, it kindles as foon as it becomes volatile: and this is the effect of the wick in candles. When diftilled in a retort, it affords febacic acid, and an oil which is at firft fluid, but afterwards fixes in the receiver, and takes the confiftency of butter. The quantity of the coal re-maining is very trifling, and it is very difficult to inci-nerate. The butter of wax, after being feveral times rectified, becomes fluid and volatile.

White wax is not liable to be altered by the air: it acquires a colour in the courfe of a certain time. It diffolves in oils, giving them confiftency. When melt-ed with thefe fluids by a gentle heat, it forms the medi-cines called *cerates*. Alcohol does not act upon wax. Acids blacken it: alkalis combine with it; and thus re-duce it to a faponaceous ftate.

Wax is ufed in many of the arts; and in pharmacy, in the preparation of pomatum, ointments, and plafters.

§ XIII. *Of*

§ XIII.   *Of Silk-Worms, the Bombic Acid, and Silk.*

THE filk-worm, efpecially in a chryfalis ftate, contains
     an acid liquor in a cell near the anus.   M. Chauf-
fier, of the academy of Dijon, obtained this acid both
by fqueezing the juice of the chryfalis through a cloth,
and precipitating the mucilage with alcohol, and by in-
fufing the chryfalis in alcohol.   When the acid is fepa-
rated by alcohol, it carries it with it through the filter;
and there remains on the paper an orange-coloured fat
oil, a gummy matter, and a little gluten.   To obtain
the bombic acid in a ftate of purity, the alcohol muft be
diftilled : on that occafion the alcohol is volatilized, and
the acid only remains in the retort.   This acid is very
pungent, and of an amber yellow colour : its nature and
combinations are unknown.

     Many other infects likewife contain acid.   It has been
remarked by M. Bonnet, that the large caterpillar of
the willow emits a liquor of confiderable acidity.   I have
often obferved the bupreftes and ftaphylini to communi-
cate a red colour to the blue paper with which boxes
containing them were lined.   M. Chauffier has likewife ob-
tained an acid from the grafshopper, the red bug, and
the lampyris, or glittering worm.

     Silk appears to be only a fort of dried gummy matter.
It differs from vegetable fubftances, 1. In affording am-
moniac by diftillation : 2. In affording azotic gas with
nitric acid : 3. In affording a peculiar oil, which is fe-
parated from it when the nitric converts it into oxalic
acid, as has been fhown by M. Berthollet.   It feems to
be a compound, confifting of a vegetable mucilage, with
a peculiar animal oil, which renders it pliant, ductile,
and elaftic.

                                        § XIV.   *Of*

§ XIV. *Of Refin Lac.*

THE name of *gum lac* has been improperly given to
a dark-red refinous fubftance, depofited on the
branches of trees by a fpecies of ant peculiar to the Eaft
Indies. This fubftance appeared to Geoffroy to be a
fort of nidus in which thofe ants depofited their eggs.
In fact, ftick lac, when broken, appears full of fmall,
regular cavities, or cells, containing fmall oblong bodies,
which Geoffroy confidered as embryon ants. He thought
the colour of the lac owing to this animal matter. The
lac he confidered as a real wax; yet, its drynefs, the aro-
matic fmell which it exhales when burning, and its folu-
bility in alcohol, render it more like refin than wax.
According to the fame writer, it affords a fort of butter
by diftillation.—In commerce, ftick lac, grain lac, and
fhell lack, are diftinguifhed from each other. It is to be
obferved, that many other colouring fubftances, parti-
cularly red animal or vegetable fæcula, when prepared
in a particular manner for dyeing, are called *lac*. In
the Levant, lac refin is ufed in dyeing cloth and fkins.
It is the bafis of fealing-wax. A tincture is formed
from it with fpirit of cochlearia. It enters into troches
of amber, dentifrice powders and opiates, odorous pa-
ftills, &c.

§ XV. *Of Kermes.*

KERMES, or chermes, *coccus infectorius*, was formerly
confidered, by naturalifts, as a tubercle or excrefcence
from plants. More accurate obfervation has fince fhewn it

to be the female of an infect, which Geoffroy ranks
among the hemiptera. This female infect fixes on the
leaves of the holm-oak : after being fecundated, it ex-
tends itself, dies, and, in a fhort time, lofes the infect
form. It has the appearance of a brown cap, inclofing a
great many eggs. This cap was formerly ufed in dye-
ing ; cochineal now fupplies its place. Kermes exhibits
the fame chemical properties with cochineal. It enters
into the confectio alkermes, &c.

§ XVI.   *Of Cochineal.*

COCHINEAL, like kermes, was long confidered as a
vegetable grain. Father Plumier was among the
firft who difcovered this to be a miftake. In fact, this
fubftance is the female of a hemipterous infect, which
differs from the kermes in retaining its form after fixing
on plants. The cochineal ufed in dyeing grows on the
opuntia, or Indian fig-tree. It is collected in great quan-
tities in South America. Geoffroy, who analyfed it,
found it to contain the fame principles with kermes, and
obtained ammoniac from it. The form of the infect may
be diftinguifhed, after macerating it in water.—Cochi-
neal is ufed in making carmine, and in dyeing. It af-
fords either a crimfon or a fcarlet colour, according as
it is ufed. Being an extractive colouring matter, it can-
not be applied to fubftances intended to be dyed, without
a corrofive. It fixes eafily on wool, and communicates
to it a fcarlet dye, by means of a folution of tin in mu-
riatic acid, which decompofes the colouring extract, and
contributes greatly to the brilliancy of the tinge.
Macquer firft taught to communicate this beautiful co-
lour to filk. That celebrated chemift difcovered a method

of

of fixing the dye on this fubftance, by impregnating the filk with the folution of tin, before immerfing it into the cochineal bath, inftead of mixing the folution with the bath, as is done in dyeing wool.

§ XVII.   *Of Crab's Stones.*

THE ftony concretion, improperly called *crab's eyes,* *lapides cancrorum,* are found in pairs, in the interior and lower part of the ftomach of thofe cruftaceous infects.   They are round, convex on one fide, concave on the other, and difpofed between the two membranes of the ventricle of the animal.   As they are found only at the time when the crab changes its fkin and ftomach, and are gradually deftroyed as the new covering of the infect gains confiftency, it has been thought, with great appearance of probability, that they contribute to the reproduction of the calcareous fubftance which forms the bafe of the fhell of the animal.

Thefe ftones have no tafte: they contain a fmall quantity of gelatinous matter.   They are prepared for ufe, by wafhing them feveral times, and levigating them with a little water, to reduce them to a foft pafte; which is wrought into little balls, and then dried.   As the water with which thefe ftones are wafhed takes up the gelatinous matter, what remains is nothing but an earthy fubftance.   When prepared in this manner, they produce a lively effervefcence with all acids, and are precifely of the fame nature with chalk.   Their only virtue is that of abforbing acid matters in the primary paffages. That opinion which ranks this fubftance among aperient, diuretic, and cordial medicines, is equally ill-founded with many other fanciful opinions which have been entertained concerning the virtues of animal fubftances.

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§ XVIII.

§ XVIII. *Of Coral.*

PRECISELY of the same nature is coral,—a fort of calcareous ramification, either white, rose-coloured, or red, which forms the basis of the habitation of the sea polypi. It is prepared in the same manner as crab's stones. Like those lapideous substances, it is of a calcareous nature. It enters into the confectio alkermes, pulvis gutteti, and amber troches. Numberless virtues have been ascribed to it; but unless combined with acids, it possesses no virtues, save those of a mere absorbent. Like crab's stones, it is often used, in a neutral state, with vinegar, or lemon-juice, as an aperient, a diuretic, &c.

§ XIX. *Of the true Coralline.*

THE coralline, called *sea-moss,* is, as has been said, a peculiar habitation of polypi. In the retort, it affords the same principles as animal matters: its taste is saltish, bitter, and disagreeable. It is used as a vermifuge, with good effects. To children, it is given in a powder, in dozes of four and twenty grains,—and to adults, in dozes of two drachms or more: an anthelmintc syrup is prepared with it: it enters into worm-powders. This common coralline must not be confounded with that which is at present called *coralline of Corsica, lemitho,* or *helminto-corton:* this last is a vegetable substance, a sort of fungus which forms a jelly with hot water.

C H A P. XV.

*General Refult of the Analyfis of Animal Subftances;
Comparifon of Animal Subftances with Vegetable
Matters.*

IN the fourteen preceding chapters, we have given the
hiftory of the prefent ftate of chemical knowledge
with refpect to animal fubftances. Thofe who have cul-
tivated chemiftry during the laft twenty years, will eafily
diftinguifh what the fcience has gained in this branch in the
courfe of that period, and what amazing progrefs it has
here made. Although many experiments ftill remain to
be performed, and many difcoveries to be made, in order
to complete the hiftory of animal matters; yet our pre-
fent knowledge of them is much more confiderable than
what was formerly poffeffed: the proper road is, at leaft,
difcovered; and we need no longer be afraid of wander-
ing in a wrong direction. It now appears plainly how
much the phyfics of animal nature may be improved by
chemiftry, and what important fervices medicine may
expect from it, when the two fciences proceed hand in

T 3   hand.

hand. If, after what is contained in the foregoing chapters, this affertion can be thought to need any additional proofs, thefe will be found in the following fhort recapitulation.

The matters which are called immediate principles of organic fubftances ; that is to fay, fuch matters as are feparated from organized bodies, directly, and without alteration ; bear a ftrong analogy to thofe which are extracted from vegetables. We find in animals, as well as in vegetables, extracts, a faccharine principle, infipid mucilages, acid and alkaline falts, fixed and volatile oils, refins, glutinous matter, an aromatic principle, and colouring fubftances. But notwithftanding this analogy, which was long ago obferved, there are fome remarkable differences between thefe immediate principles of the two kingdoms, the examination of which is of fufficient importance to engage the attention of philofophers.

1. The extract and the faccharine matter, are not near fo copious in animal as in vegetable matters.

2. The mucilages of animal are fomewhat different from thofe of vegetable bodies : they are fofter, eafier dried, and capable of attracting moifture from the atmofphere ; they form into a jelly by cooling ; their tafte is ftronger, too, and they become four, and putrefy much fooner.

3. The fixed oils of the animal kingdom are alfo different from thofe of vegetables. They are found in certain cells, in much larger quantities : they are always more or lefs concrete, and often fufceptible of deficcation and cryftallization.

4. Volatile oils and refins are in general much lefs copious among animals than among vegetables. It would appear, that nature has carefully removed from the fenfible and irritable organs of animals, thofe acrid fub-

ftances

ſtances which would have continually ſtimulated the fibres: even in vegetables, they are diſpoſed near the exterior tunics.

5. Albuminous matter, liable to concretion by heat, though to be found among the juices of vegetables, is leſs copious in them than in animals, all whoſe parts generally contain a conſiderable quantity of it.

6. The ſubſtance of the fibres of animals, though ſomewhat ſimilar to the gluten of flower, is however more tenacious and elaſtic ; and beſides, its proportion is ſo conſiderable, that were there no other difference between animals and vegetables, this alone might well engage the attention, and employ the induſtry of phyſiologiſts. All the muſcles or organs of motion are compoſed of it ; and as animals diſplay motive powers which are not obſerved in vegetables, the parts in which thoſe motive powers reſide, muſt be eſſentially different from the motionleſs bodies of plants.

7. But animal differ ſtill more from vegetable matters, in the nature of the ſaline ſubſtances which they contain. Beſides the ſalts and radical principles of ſaline bodies in animal matters, of the ſame nature with thoſe which vegetables contain, ſuch as lime, ſoda, the muriatic, oxalic, malic, benzoic, ſebacic, and phoſphoric acids ; they afford alſo the lactic, ſaccholactic, lithic, formic, and bombic acids, whoſe nature is not known, but which do not appear to exiſt in vegetables. In animals, too, the principles from which ammoniac acid is formed, exiſt in greater abundance than in vegetables ; and this is what moſt eminently diſtinguiſhes animal from vegetable matters. The principles requiſite to the formation of ammoniac and the pruſſic acid, azote, hydrogene, and carbone, are even ſo copious in animal ſubſtances, that theſe compounds are very often ready formed, eſpecially

in

in animals a short time after death. I have found
Prussian blue in putrid animal matters. I have even
seen the blood of a sick person, which was very much
altered, assume a bright blue colour, on exposure to the
air. But it must be acknowledged, that vegetables like-
wise contain the principles of the prussic acid, though not in
so great abundance. As to ammoniac, its being formed
much easier, and much more frequently in animal matters
than in vegetables, shows that the former contain its
principles in much greater abundance than the latter:
And in fact, M. Berthollet has proved, that those mat-
ters afford a much greater quantity of azotic gas than
the others, with the nitric acid. I have also proved,
that after the azotic gas is extracted from animal sub-
stances, they no longer afford ammoniac. It is therefore
to this principle they owe their property of affording,
either by a natural or an artificial analysis, a great
quantity of this alkaline salt.

If we enquire, then, what are the more simple primary
principles of which those immediate principles are com-
posed; it will be found, that the only component prin-
ciples of animal matters, as well as of vegetable sub-
stances, are, hydrogene, carbone, azote, and oxigene,
These bodies, which, as they have not yet been decom-
posed, may be said to be in some measure elementary,
appear to constitute, by various combinations with one
another, oils, acids, mucilages, the fibrous part, &c.
These more immediate principles, again, differ from each
other only in the number and the proportions in which
the primary substances are combined in them. But, as
animal matters, though consisting in general of the same
principles with vegetable substances, are however really
different in their properties; the difference must be
owing to their containing the primary principles in dif-
ferent

ferent proportions. The fuperior proportion in which animal matters contain the principle of azote, accounts for a great many of thofe differences : it explains why animal fubftances afford a great deal of ammoniac by the action of fire ; why they putrefy fo foon ; why they are neceffary to the production of acid of nitre, &c.—The only thing which now remains to be enquired into, is, What change vegetable matters undergo, when they pafs into animal bodies ? For it is certain, that none but vegetable matters are proper for the nourifhment of animals, or convertible into animal fubftance. It is firft to be obferved, that many of the immediate principles of vegetables pafs unaltered into the bodies of animals, ftill retaining their peculiar nature,—or at leaft fuffer but very little alteration ; fuch, particularly, are various falts, fixed oils, &c. But the different forts of mucilage, the gluten, and colouring fubftances, manifeftly undergo a change of nature : the gummy matter becomes gelatinous, and the gluten is converted into the fibrous part ; the bafe of azotic gas, or azote, becomes fixed in thofe fubftances, and combines with them in a large proportion : and the fixation of this principle feems to convert vegetable into animal matter. This change, and the formation of the different animal fubftances, fhould chiefly engage the attention of phyfiologifts : this, in fhort, is the great problem with regard to animal nature which remains to be folved. Analyfis has already fupplied fome valuable facts towards this folution ; but many more are ftill wanting : and it is only by accurate chemical proceffes, that we can hope to obtain a fufficient number for the accomplifhment of fo defirable a purpofe.

CHAP.

CHAP. XVI.

Of the Putrefaction of Animal Substances.

VEGETABLE matters, though liable to be decompos-
ed, and even entirely destroyed by putrid fermenta-
tion, are, however, far from being so liable to that intestine
emotion as animal matters. The putrefaction of these
last matters is much more rapid than that of the others,
and exhibits very different phænomena. All the fluids,
and all the soft parts of animals, are alike subject to it;
but many vegetable matters seem to be entirely secure
from it,—or, at least, it takes place on them very slowly,
and with very great difficulty.

The putrefaction of animals, which one cannot help
considering, with Boerhaave, as a real fermentation, is
one of the most important phænomena in nature, and,
at the same time, very difficult to understand. All the
researches of philosophers, from the days of Lord Bacon
of Verulam, who saw its importance, to the present
time, have explained only a few circumstances, and examin-
ed only the general phænomena of putrefying matters.

Beccher,

Beccher, Hales, Stahl, Pringle, Macbride, Gaber, Baumé, the refpectable Author of the Effays on Putrefaction, and the Authors of the Differtations on Antifeptics, which obtained prizes from the Academy of Dijon in the year 1767, have obferved the phænomena which attend the putrid alteration of fubftances, and defcribed them with fufficient care. But, from the account which we are about to give of what is known concerning this matter, it will appear, that a great number of future experiments are neceffary, to make us acquainted with all the particulars of what paffes in this operation of nature.

Every fluid, or foft extract of an animal body, when expofed to the temperature of fixty-five degrees, or fomewhat more, undergoes, with more or lefs rapidity, the following alterations : Its colour becomes pale, its confiftency is relaxed : If a folid part, fuch as flefh, it becomes foft, and exfudes a ferous matter, the colour of which is very foon altered ; its organization is deftroyed ; its fmell becomes infipid and difagreeable ; by degrees, this altered fubftance decreafes in bulk, and its fmell becomes ammoniacal. After this, if it be preferved in a clofe veffel, the putrefaction appears to proceed more flowly ; none but an alkaline, pungent fmell is felt from it :—the matter effervefces with acids, and turns the fyrup of violets green. But, when air is admitted, the urinous exhalation goes off, and a peculiar, infufferable putrid fmell rifes from it with a degree of impetuofity : this fmell continues for a long time, penetrates every where, and feems to affect the bodies of animals, like a fermenting fubftance capable of altering their fluids. This fmell is corrected, and in fome meafure confined, by the ammoniac. After the volatilization of the ammoniac, the putrefaction proceeds with new energy : the putrefying

<div align="right">mafs</div>

mafs fuddenly fwells, and appears filled with bubbles of an elaftic fluid ; but foon fhrinks a-new : its colour is al-tered, and the fibrous texture of the flefh is now fcarce diftinguifhable : it is changed into a foft matter, of the confiftency of a poultice, and either brown or greenifh : its fmell is infipid and naufeous, but acts with great energy on animal bodies.   This odorous principle by de-grees lofes its ftrength : the fluid part of the flefh be-comes, in fome meafure, confiftent : its colour becomes deeper ; and it is at laft reduced to a friable matter, half-dry, yet fomewhat deliquefcent ; which, by friction with the finger, breaks into a coarfe powder, like earth. This is the laft ftate that has been obferved of the pu-trefaction of animal fubftances ; they take a confiderable time to reach this point, which is, however, fometimes longer, fometimes fhorter.   Eighteen months, nay two or even three years are fcarce fufficient for the compleat deftruction of the whole texture of an animal body ex-pofed to the air ; and the length of time which paffes before the entire deftruction of carcafes buried in the ground, has not been yet afcertained.   Not to fpeak of bodies which become dry in certain foils, and remain without fuffering farther alteration,—many facts prove, that dead bodies buried in moift earth, are not deftroy-ed even in the fpace of 30 years.

From thefe particulars, it follows, **1.** That the cir-cumftances neceffary to excite and carry on the putre-faction of animal fubftances, are, the contact of air, heat, moifture, and reft or inactivity ;—maffes of animal mat-ter, in order to putrefy, muft be fubject to all thefe cir-cumftances : 2. That ammoniac is one of the products of putrefaction, and is formed during the fermentation ; as it did not before exift ready-formed in thofe fubftances : 3. That the putrefaction, accomplifhed by an internal motion pe-culiar

culiar to organized bodies, may be compared to the action of fire, as has been remarked by M. Goddard ; and confidered as a fpontaneous decompofition, as thinks M. Baumé ; differing from that action only in taking place more flowly: 4. That in this natural operation, the proximate principles of animals react on each other with the help of water and heat, which firft excite the emotion ; and accordingly, the newly-formed volatile matters are, by degrees, diffipated, in the order of their volatility, till nothing is left at the end of the putrefaction, but an infipid, and feemingly earthy refidue : 5. That the putrid exhalation, the character of which is fo well diftinguifhed by the olfactory nerves, and which acts with fuch energy on the animal œconomy, is to be confidered as one of the principal products of putrefaction, fince it is peculiar to this operation, and not obferved in any other natural phænomenon ; and fince, befides, it appears capable of exciting a putrefactive emotion in all other animal fubftances expofed to its action. As to the nature of this fugitive odorous fubftance ; it is particularly on this point that our refearches have made but fmall progrefs, and fhould be farther profecuted. What we know of it, proves it to be extremely volatile, fubtle, and penetrating in its nature ; and that pure air, water in a large proportion, and acid gafes are capable of moderating its effects. Although it muft not be confounded with carbonic acid gas, a great deal of which is difengaged from putrefying bodies, and to the difengagement of which alone Macbride afcribed the caufe of this natural phænomenon ; and although it muft not be confidered as refembling either the hydrogenous gas which is difengaged from putrefying bodies, or the luminous matter which fparkles on the furface of putrid animal fibres, and renders them phofphoric ; yet it cannot be denied, that there fubfift between

tween it and thoſe ſubſtances ſome pretty ſtrong relations, as it invariably accompanies them, is equally ſubtle and volatile, and acts with the ſame energy on the organs of animals.

We may obſerve, with M. de Boiſſieu, that there are four different degrees in the putrid fermentation of animal ſubſtances.

The firſt, which that philoſopher calls *tendency to putrefaction*, conſiſts in a ſlight alteration, which appears to take place by the diffuſion of a ſort of muſty ſmell, and the ſoftening of the ſubſtances.

The ſecond degree, that of *putrefaction commencing*, is ſometimes indicated by marks of acidity. Matters in this degree of putrefaction, loſe a part of their weight, become ſoft, and give out ſerous matter, if in cloſe veſſels; but, if expoſed to the open air, they rather become dry and dark-coloured.

In the third degree, that in which *putrefaction has made ſome progreſs*, the putreſcent matters exhale an ammoniacal ſmell, mixed with a putrid and nauſeous ſmell: they are then diſſolved, and their colour more and more altered; and they at the ſame time ſuffer a loſs of weight, and decreaſe in bulk.

Laſtly, the fourth degree, that in which *putrefaction appears compleated*, is diſtinguiſhed by the ammoniac's being now entirely diſſipated, and no trace of it remaining: the fœtid ſmell is now fainter, and the weight and bulk of the putrefied ſubſtances are conſiderably diminiſhed: a gelatinous mucous matter is ſeparated from them; they become gradually dry, and are at laſt reduced to a friable, earthy matter.

Such are the general phænomena obſervable in the putrefaction of animal ſubſtances; but they are far from taking place uniformly in all inſtances of the putrefaction

of

of animal fubftances. In the firft place, there is a wide diftinction between the manner in which parts of the living bodies of animals putrefy, and that in which this change takes place on dead carcafes. In the former, the vital functions modify the phænomena of this alteration in a particular manner: phyficians have frequently occafion to obferve the differences between thefe two ftates of animal bodies, in refpect to putrefaction. Befides, every different humour, every different folid part in an animal body putrefies in a peculiar manner. The mufcular, membranous or parenchymatous texture of the organs,— the oily, mucilaginous or lymphatic nature of the humours,—their confiftency,—their ftate with refpect to that of the animal to which they belong,— all influence the emotion of putrefaction, and modify it in a thoufand different ways, which it would perhaps be impoffible to difcriminate. Laftly, the ftate of the air, its temperature, its elafticity, its weight, its drynefs or moifture, the particular local fituation of the putrefying fubftance, and the very form of the veffel in which it is contained, are all likewife to be taken into account; for all thefe circumftances contribute to diverfify the phænomena of this fpontaneous decompofition of bodies. It muft therefore be acknowledged, that we are not yet acquainted with more than the outlines of the hiftory of the putrefaction of animal fubftances; and that, to fill thefe up, a long feries of refearches and experiments is requifite.

Thofe phænomena, of putrefaction which *have* been obferved, fhew that it is owing originally to water : moft probably, that fluid is decompofed ; and its oxigene combining with the azote of the animal fubftances, thereby produces the nitric acid which they are fo frequently found to contain ; and its hydrogene, again, may unite
with

with another part of the azote, which is very copious in those matters, to form the ammoniac that is disengaged. The oily principle is separated, and remains longest unaltered. The calcareous phosphate, and phosphate of soda, in union with a portion of pure carbonaceous matter, and perhaps a little fat matter, seem to compose the apparently earthy residue of putrefied animal matters.

We have, as yet, described only the phænomena which take place on animal matters, when they are decomposed by putrefaction in the open air. As the phænomena of that decomposition in different media, tend to illustrate the revolutions which take place on our globe, let us consider, for a little, what happens to those matters, when they putrefy in water, or under ground.

The changes which take place in water are not quite the same with those above described. Animal bodies immersed in that fluid, first swell: elastic fluids are next disengaged from them : the water dissolves a great part of their principles, decomposes another part, and disperses those constituent principles over large masses of water : accordingly, many people have exposed their dead carcases in rivers, and trusted to the waters for their destruction.

Different phænomena take place when animal bodies are buried under ground. Observations, most of which were accidentally made, have shewn, that they are more rapidly or more slowly destroyed, according to the nature of the soil. Bodies are sometimes found to be totally destroyed in a little time; and sometimes they are found in a good state of preservation, even after lying a long time under ground. It may be easily conceived, that where the earth is very porous and light, and the animal matter disposed near the surface, air, and especially water, will then obtain easy access, and contribute to its decomposition.

pofition. In oppofite circumftances, the decompofition
muft naturally be much flower. Dry earth, for inftance,
abforbs water from bodies, renders them dry, and con-
verts them into mummies. A fandy foil, in which bodies
are expofed to the impreffion of a fcorching fun, pro-
duces a fimilar effect, giving them a degree of hardnefs
which renders them fecure againft deftruction for ages.
Argillaceous earth, again, retains water, and therefore
favours the putrefaction of bodies. In cafes in which it
takes place, either fooner or later, the fluids and folids
are at laft reduced almoft entirely into azotic gas, carbo-
nic acid gas, hydrogenous gas, and ammoniac gas. All
thefe elaftic fluids, as they filtrate through the earth, are
in part flopped in their progrefs, and rendered fixed;
and accordingly render the mould black, fat, and foetid.
Thefe products of putrefaction faturate the mould in
fome meafure, till they are at length carried off by the
diffolving action of water and air, evaporation by heat,
and abforption by vegetables. Thus, nature, by a flow
decompofition, reduces animal bodies, after they are de-
prived of life, into more fimple fubftances, fitted to enter
into new combinations.

This decompofition confidered, as it takes place, all
over the globe, at once, on the earth, in the air, and in
water, gives rife to fome important changes in nature,
which philofophers fhould obferve and afcertain. When
we obferve the wide extent of the fea, and the immenfe
number of animals by which it is inhabited, it appears,
that vaft quantities of animals perifh in it, which, by
their fpontaneous decompofition, muft give rife to a num-
ber of phænomena that have been, as yet, but too little
examined. What becomes of all thofe remains of animal
bodies? What fucceffive revolutions do they undergo?
Sea-water is known to contain muriate and fulphate of

ſoda, lime, and magneſia: No doubt, muriatic acid, mag-
neſia, lime, and ſoda, are continually forming in this la-
boratory; nay, perhaps, the formation of many of theſe
ſubſtances may be carried on by marine animals, during
their lives: but others of them can be owing only to the
decompoſition of the ſame animals after death. It can-
not be denied, that the ſtrata of calcareous matters,
which compoſe, as it were, the ſhell or cruſt of our
globe over a very conſiderable part of its ſurface, have
been originally produced from the remains of marine ani-
mals, more or leſs broken by the action of the waters;
that thoſe ſtrata have been primarily depoſited at the
bottom of the ſea; and that bitumen, and earth-coal
which is depoſited in very thin and extenſive ſtrata, both
of which ſubſtances occupy a part of the globe, have
been originally produced in this manner. In the ſeas,
therefore, there is a decompoſition of water conſtantly
carried on: innumerable agents are ever ſeparating its
principles, and ſuffering alterations themſelves. Immenſe
maſſes of chalk, from time to time depoſited on the bot-
tom, abſorb and fix, that is, convert into ſolid ſubſtance
a part of the liquid with which that capacious reſervoir
is conſtantly filled.

From theſe reflections on the decompoſition of animal
ſubſtances, in the earth, the air, and the waters, with
all the aſſemblage of facts which chemiſtry ſupplies con-
cerning it; it follows, that the exterior ſtrata of the
globe are now different from what they originally were:
that it is increaſing in ſolidity and extent by the ſuccef-
ſive and uninterupted accumulation of calcareous matter
from the deſtruction of animal bodies: that the ſoil of
the earth which we inhabit is modern and factitious:
that minerals are not be conſidered as forming a part of
this ſoil: that it has been produced from a ſlow decom-
poſition

position of animal and vegetable bodies : that water is constantly diminishing in quantity, and assuming a new form : that one part of decompofed water forms one of the bafes of animal and vegetable bodies : that another part enters, in a folid form, into the calcareous ftrata of the globe : that the atmofphere muft have been influenced and modified by all thofe changes : that vegetables are continually influencing the ftate of atmofpheric air ; and that the light of the fun acts an important part in the production of all thefe mutual alterations. Although it may appear impoffible to determine the length of time in which the decompofition of water, vegetation, fermentation, putrefaction, the formation of faline matters, bitumens, and calcareous fubftances, and their modifications, have been fucceffively carried on ; yet the modern difcoveries with which chemiftry and natural philofophy have been enriched, fhew, that thofe phænomena have taken place at different periods ; that they continue to modify the prefent ftate of our planet : And that, if matter *be*, as great philofophers affert, only one fubftance, as to its mafs and intimate nature ; yet its form is continually varying by new combinations, and gradually experiencing great revolutions ; of which modern chemiftry,—and modern chemiftry alone, can afcertain the caufe, and may, one day, determine the ultimate effects.

CONTE

CONTINUATION

Of the ANIMAL KINGDOM.

Of the Methodical Classification and the Natural Histo-ry of Animals.

AS the inferior animals on our globe are so numerous, it would be impossible for mankind to distinguish them from one another, or gain any considerable know-ledge of their nature and habits, if they did not exhibit remarkable differences, which render it easy to establish distinctions among them. Naturalists have always been sensible of the utility of those differences; and by divi-ding animals according to them, either into more or fewer classes, have happily formed what are called *me-thods.* Though it be certain that no such classifications exist in nature, and all the individuals which she has pro-duced

duced form one continued, uninterrupted series; yet they muft be allowed to affift the memory, and to form truly ufeful guides in the ftudy of natural hiftory. Methods are therefore to be confidered as inftruments fuited to our weaknefs, which may be happily made ufe of in tracing the wide field over which the ftores of nature are ftrewed. The divifions which Ariftotle eftablifhed, were very general and fimple; but his ingenious reflections on the internal and external organs of animals, formed the bafis on which moft of the firft naturalifts who attempted methodical divifions—fuch as Aldrovandus, Johnfton, Charleton, Ray, &c. eftablifhed them. Thofe naturalifts have been fucceeded by a number of others, by whom their methods have been improved, and much added to the knowledge which they had collected. Among the latter, thofe whofe works are moft worthy of being ftudied, and from which what follows here on this fubject is borrowed, are Meffrs Klein, Arthedi, Briffon, Daubenton, Geoffroy, &c.

After man, the organization of whofe body, and the intelligence with which he is endowed, entitle him to be ranked at the head of all the animals inhabiting our globe, in a feparate clafs,—all the other animals may be arranged in eight claffes:—Quadrupeds, Cetaceous Animals, Birds, Oviparous Quadrupeds, Serpents, Fifhes, Infects, and Worms, with which may be affociated Polypi.

Thefe claffes might perhaps be rendered much more numerous. But, with the divifions, the difficulties of the ftudy would be increafed: and this is to be carefully avoided, in an artificial method; as fuch a method muft owe all its value to fimplicity and perfpicuity. M. Daubenton, who has laboured much on the claffification of animals, has arranged them in the fame manner; and,

U 3 *under*

under each clafs, has confidered the ftructure of the principal parts of the animals contained in it ; fhewing, that from man to the worm, animals become gradually more imperfect in their organization. (*See Table I. at the end of this volume.*)

In the hiftory of animals, there are two principal objects of attention : 1. Their external forms, and the methods founded on thofe forms : 2. Their internal organs, and the functions for the performance of which they are deftined. Thefe two diftinct objects we fhall confider in two feparate Sections.

SEC.

SECTION I.

A Sketch of the different Methods of the Natural History of Animals.

ARTICLE FIRST.

Of Quadrupeds. ZOOLOGY.

QUADRUPEDS are animals with four feet, whofe bodies are generally covered with hair. They refpire by lungs, like the human fpecies: they have alfo a heart, with two ventricles: they are viviparous. Their ftructure, more than that of any other animals, refembles the ftructure of the human body. Some of them, fuch as the ape, and a few others, have even been ranked by Linnæus in the fame clafs with man. That naturalift gives this clafs of animals the name of *mammalia*,— comprehending, alfo, cetaceous animals, becaufe thefe, too, have breafts, and fuckle their young.

<center>U 4</center> <div align="right">Although</div>

Although this clafs of animals may feem to be nearly
of the fame order with man ; yet, between the two,
there are fome ftriking differences, which we may here
enumerate :—The horizontal difpofition of their bodies,
the form of the extremities, the groffnefs of the body,
the ftiffnefs of the fkin—which is either covered with
hair, or with a hard and corneous cruft ; the prolonga-
tion of the back-bone into a tail ; the flat, horizontal
form of the anterior part of the cranium, the length
and breadth of the ears, the extreme length and oblique
difpofition of the bones of the nofe and the upper-jaw :
—thefe are all properties in which this clafs of ani-
mals differs from the human fpecies. The difpofition of
the human body, again, is elevated and perpendicular ;
the bone of the radius is moveable at the elbow, the
fingers are feparate, the thumb placed oppofite to the
other four, and the fkin fmooth and thin.—This differ-
ence of ftructure muft evidently improve the fenfibility
of human beings, and render them much fuperior to the
moft perfect of the other animals.

Ancient naturalifts, at the head of whom are Ariftotle
and Pliny, did not think of diftinguifhing quadrupeds any
other way but by the regions which they inhabited :
Accordingly, fuch is the inaccuracy of their defcriptions,
and fuch the uncertainty of thofe characteriftics which
they have pointed out, that we are often at a lofs to dif-
cover what animals they allude to. Naturalifts, fenfible
of the inconveniences attending this method, have fince
adopted a very different mode, in their defcriptions of
the objects of natural hiftory. From the exterior form
of the moft confpicuous parts of animals, they have affum-
ed characteriftics eafily difcernible, and fufficient to efta-
blifh certain diftinctions. We fhall here give an account
of

of only three artificial methods of arranging quadrupeds: thofe of Meffrs Linnæus, Klein, and Briffon.

The METHOD *of* LINNÆUS.

LINNÆUS divides animals with teats, *mammalia*, into feven orders. The firft comprehends thofe which he calls *primates*, the characteriftics of which are incifory teeth in both jaws; in the upper-jaw, always four teeth; two teats on the breaft; and the arms feparated by a collar-bone. In this order there are four genera; namely, man *homo*, the ape *fimia*, the maki *lemur* or *profimia*, and the bat *vefpertilio*. It muft be acknowledged, that this method does not very well agree with nature; for there is fo wide a difference between man and the bat, that it is almoft fhocking to clafs them together.

The animals of the fecond order are denominated *bruta*. Their characteriftics are, the want of incifive teeth, feet with ftrong hooves, and flownefs of motion in walking. This order contains fix genera; the elephant *elephas*; the fea-cow *trichechus*, the floth *bradypus*, the ant-eater *myrmecophaga*, the philodotus *manis*, and the tatou, or *dafypus*. There is a wide difference between the two former genera, and the latter four.

In the third order, which the Swedifh naturalift denominates *feræ*, wild beafts, he includes all animals with paps, whofe incifory teeth are of a conical form, and generally in the number of fix to both jaws,—the canine teeth very long, and the molares not flattened,—their feet armed with claws,—and who, in their habits of life, are rapacious and devour their prey. In this order, there

there are ten genera; the fea-calf *phoca*, the dog *canis*, the cat *felis*, the ferret *viverra*, the weafel *muftella*, the bear *urfus*, the *didelphis*, the mole *talpa*, the moufe *forex*, and the hedgehog *erinaceus*.

The fourth order, intituled *glires*, the dormoufe, is diftinguifhed by the following characteriftics. The animals belonging to it have two incifory teeth on each jaw, but no canine teeth. On their feet, they have claws which fit them for leaping. They gnaw the bark and roots of trees, &c. This order comprehends fix genera; the porcupine *hiftria*, the hare *lepus*, the beaver *caftor*, the rat *mus*, the fquirrel *fciurus*, and the American bat, named by Linnæus *noctilio*.

Under his fifth order, *pecora*, this naturalift comprehends all thofe quadrupeds which have incifory teeth on the under-jaw, but none on the upper, which have their hooves divided, and which chew the cud. The camel *camelus*, the animal which affords mufk *mofchus*, the ftag *cervus*, the goat *capra*, the fheep *ovis*, and the cow *bos*, are the fix genera of which this order confifts.

Under the denomination of *belluæ*, the fixth order, he comprehends quadrupeds with obtufe, incifory teeth, and hooves on their feet. The four genera of which this order confifts, namely, the horfe *equus*, the river-horfe *hippopotamus*, the hog *fus*, and the unicorn *rhinoceros*, are fufficiently diftinguifhed from one another, by the number of their teeth, and the form of the feet.

Laftly, the feventh order, comprehending cetaceous animals, *cete*, is diftinguifhed from the other orders by the form of the feet of thefe animals, which refemble the feet of fwimming animals. As, however, we agree in opinion with feveral modern naturalifts, who think

that

that cetaceous animals should be ranked in a particular clafs, we shall speak of them after quadrupeds.

The method of Linnæus appears to be in many inftances defective ;—not only in bringing man and the bat, &c. improperly together, and in dividing with equal impropriety animals so nearly resembling each other as the rat and the moufe, &c.; but its divisions are far from being sufficiently numerous ; nor will they help the student to distinguish any particular quadruped : And this is what must constitute the great merit of a fystem of arrangement ; — this is indeed the only advantage that can be gained by it.

KLEIN's METHOD.

KLEIN divides quadrupeds into two great orders; the first, comprehending quadrupeds with hooves, *pedes ungulati five cheliferi ;* the second such as have their feet digitated, *pedes digitati.*

The first order is divided into five families, which are distinguished from each other according to the division of their hooves. The first family, called *monochela,* (in French *folipede*) *single-hoofed,* comprehends the genus of the horfe.—The fecond, the individuals of which are distinguished by the name of *dichela,* consists of those quadrupeds whose hooves are parted into two, or bifulcar *bifulci.* Some of these, such as the bull, the ram, the buck, the stag, the giraffe, &c. have horns. Others again, such as the boar, the hog, the babyroussa, are without horns.—The third family contains the *trichela,* or animals
mals

mals which have the hoof parted into three; of which there are none but the *rhinoceros.*—In the fourth family, whose peculiar characteristic is, to have the hoof parted into four, *tetrachela*, there is only the hippopotamus, —The elephant, the only animal whose foot is parted into five divisions, constitutes the fifth family, *penta-chela.*

The second order of quadrupeds, containing those which are digitated, is likewise divided into five families. The first consisting of animals with two toes on the foot, *didactyla*, comprehends the camel, and the sloth of Ceylon.—The second family, animals with three toes on the foot, *tridactyla*, consists of the sloth and the ant-eater.— In the third, Klein comprehends, under the name of *tetradactyla*, animals with four toes, tatous or amadilloes, and the *cavia*, which seems to be a sort of rabbit.— The fourth family, characterised by having five toes, *pentadactyla*, is more numerous than any of the former families: it contains the rabbit, the squirrel, the dormouse, the rat and the mouse, the didelphis, the mole, the bat, the weasel, the porcupine, the dog, the wolf, the fox, the *coati*, the cat, the tiger, the lion, the bear, and the ape :—a very considerable number of species are comprised under these different genera.   It is to be observed, that in all these characteristics, taken from the form of the feet, Klein, in distinguishing the families, considers only the fore-part of the foot.—Lastly, the fifth family of digitated animals consists of animals whose feet are irregular in respect to the number and division of their toes, *anomalopoda ;* such as the otter, the beaver, the sea-cow, and the phocas or sea-calf.

The same objection may be made to Klein, as to Linnæus.   The families are, indeed, sufficiently distinguished from one another; but the genera, especially those

of the fourth family of digitated animals, cannot be well difcriminated in his fyftem.

METHOD *of* M. BRISSON.

M. BRISSON has avoided moft of the defects of other fyftems, by combining together all the characteriftics which had been affumed by preceding naturalifts :—The number of the teeth, the want of teeth, the form of the extremities, the fhape of the tail, and the nature of the appendices—fuch as horns, fcales, and prickles. His fyftem cannot be denied to be the moft compleat, and the beft contrived to help us to diftinguifh any quadruped, and refer it to the genus to which it belongs. His divifions are here exhibited in a table : it contains the generic characteriftics of animals ; and is very fimple and eafy.—*See Table II. at the end of this volume.*

ARTICLE II.

Of Cetaceous Animals.

CETACEOUS animals, are great animals inhabiting the feas, which are enabled, by the ftructure of their lungs and blood-veffels, to live under water,—as we

we fhall explain more particularly in the hiftory of re-
fpiration. Being viviparous, they refemble quadrupeds
in the ftructure of their breafts, and of their internal or-
gans in general; but the form of their extremities is dif-
ferent,—as thefe fpread into fins : And they have, be-
fides, two apertures in the upper part of the head,
through which they fpout water to a confiderable height.
Thefe holes are called by naturalifts *fpiracula*. M. Dau-
benton tranflates this word *(events) vents*. Thefe ani-
mals are far from being equally numerous with quadru-
peds. M. Briffon diftinguifhes them, 1. into Cetaceous
animals' wanting teeth, fuch as the whale *balæna ;*
2. Cetaceous animals which have teeth only in the upper-
jaw, fuch as the *cachalot, monodon vel monoceros ;* 3. Ce-
taceous animals with teeth only in the under-jaw, fuch
as the narval or unicorn of the fea, *phyfeter ;* 4. Laftly,
Cetaceous animals having teeth in both jaws, fuch as the
dolphin, *delphinus*.

ARTICLE III.

Of Birds. ORNITHOLOGY.

BIRDS are animals with two feet, which move through
the air by means of wings, are covered with feathers,
and have bills of a corneous fubftance. Many facts con-
cerning the forms of the bills, the ftructure of the fea-
thers,

thers, the motions and the habits of thefe animals, are highly worthy of attention. The moft important of thofe facts will be given in an abridgement of phyfiology, which is to follow in this volume. At prefent, we are only concerned to give the external characteriftics by which the animals are diftinguifhed, and fyftematically arranged. The firft philofophers who treated of this part of natural hiftory, eftablifhed no diftinctions among birds, but fuch as depended on their inhabiting in different fituations. They diftinguifhed them into birds of the woods, birds of the plains, birds of the thickets, fea fowls, river-fowls, and birds frequenting lakes, &c. Others have diftinguifhed them by the fpecies of food on which they live,—into birds of prey, granivorous birds, &c. &c.

But the moderns who have formed fyftems of natural hiftory, have taken a very different way of eftablifhing characteriftic differences among them. Linnæus has divided them, by the form of the bill, into fix orders, in the fame manner as quadrupeds, with which he compares them. But thofe divifions do not appear to be fufficiently numerous; efpecially as the number of the fpecies of birds is much more confiderable than that of quadrupeds. Buffon makes the quadrupeds which are known, amount to two hundred different fpecies; but the fpecies of birds to fifteen hundred or two thoufand.———We fhall here fpeak only of Klein's and M. Briffon's fyftematical arrangements of birds.

Klein divides birds into eight families, according to the form of their feet. The firft, under the name of *didactylæ*, confifts of fuch as have two toes on the foot: —the only bird belonging to this divifion is the oftrich.—The fecond confifts of *tridactylæ*, fuch as the cafuary, the buftard, the lapwing, the plover.—The

third,

third, the *tetradactylæ*, have two toes before, and two behind, such as the parrot, the woodpecker, the cuckoo, and the king's-fisher.——The fourth comprehends the *tetra-dactylæ* which have three toes before, and one behind. This family is more numerous than any of the rest : it comprehends both diurnal and nocturnal birds of prey, ravens, magpies, starlings, thrushes and blackbirds, larks, red-breasts, swallows, tom-tits, woodcocks, bulfinches, rails, crossbills, gallinaceous fowls, herons, &c.——The fifth family contains *tetradactylæ* having their three fore-toes connected by a membrane, but the toe behind separate. These birds are called *palmipedes*. This family consists of geese, ducks, sea-mews, and divers.——The sixth comprehends those *tetradactylæ* which have all the four toes connected by a membrane. They are called in Latin *planci*. The pelican, the cormorant, the *fool*, and the anhinga, are ranked by Klein in this family.——The seventh consists of those who have only three toes, and those connected by a membrane : they are denominated *tridactylæ palmipedes*. The guillemot, the penguin, and the albatrofs, belong to this family.——Lastly, the eighth consists of *tetradactylæ* having on their toes fringed or scolloped membranes. They are called also *dactylobæ*. This last family consists of the *colimba* and the coot.——Klein's method, though it descends to more particulars than that of Linnæus, is still attended with numerous difficulties as to the distinctions of the genera ; especially those of the fourth family. We therefore think M. Brisson's preferable. The last, indeed, as the author has made use of the different characteristics in the same manner as in his classification of quadrupeds, appears at first sight to be very complicated ; but when reduced to a table, as we have done with it, it exhibits, at one glance, all the divisions of which it consists ; and

any particular bird may be eafily diftinguifhed, by tra-
cing thofe divifions.——*See Table III. at the end of this
volume.*

ARTICLE IV.

Of Oviparous Quadrupeds.

LINNÆUS, in his fyftem, arranged together, oviparous
quadrupeds, ferpents, and cartilaginous fifhes, under the
name of *amphibia.* But, M. Daubenton is of opinion,
that the word *amphibia* cannot be properly applied to
any clafs of animals : for it muft mean animals which live
either in air or in water, as long as they pleafe ; and
there is no clafs poffeffed of this property : Were the
denomination, again, to be applied to all terreftrial ani-
mals capable of living for any fpace of time, however
fhort, under water,—and all aquatic animals capable of
living in the air,—all animals would then be amphibious.
In the fame clafs, but in two diftinct orders, Linnæus
ranks both oviparous quadrupeds, and ferpents ; and
thofe amphibious animals which practife fwimming, he
ranks among fifhes.

In M. Daubenton's fyftem, oviparous quadrupeds
compofe the fourth order of animals. Their organiza-

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tion is by no means imperfect : for they, like the quadru-
peds, cetaceous animals, and birds ranked before them,
have a head, noſtrils, and ears ſituated within the
head.   But, the following characteriſtics diſtinguiſh this
claſs from the three preceding orders : 1. They have
only one ventricle in the heart ; 2. Their blood is almoſt
cold ; 3. They reſpire only after long intervals ; 4. They
are oviparous, and conſequently without teats.—The
laſt of theſe characteriſtics is common to them with the
four following orders of animals.   Laſtly, no other ani-
mals but they, have four feet, without hair.

M. Daubenton obſerves, that the differences among
the various genera belonging to this order are ſo conſi-
derable, as to render it impoſſible to communicate any
general notions common to them all.   Of this he treats
in the hiſtory of each particular genus, under the words,
tortoiſes, lizards, toads, frogs, in the ſecond volume of
the Natural Hiſtory of Animals, which forms a part of
the *Encyclopædie Methodique.*

The claſſification and the characteriſtics which that
celebrated naturaliſt has given of the order of oviparous
quadrupeds, is one of the moſt compleat and the beſt exe-
cuted parts of the natural hiſtory of animals : And I have,
therefore, formed into a table, all M. Daubenton's divi-
ſions, from claſſes to ſpecies, as the number of the ſpe-
cies is not above 100.—(*See Table IV.*)   Since the pub-
lication of M. Daubenton's work, the Count de la Cepede
has publiſhed a very compleat and accurate work on ovipa-
rous quadrupeds, in which he exhibits a peculiar method
of arrangement.   This method is laid down in the
fifth table, which is extracted from M. de la Cepede's
work.

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ARTICLE V.

Of Serpents.

SERPENTS form the fifth order in M. Daubenton's
division of animals. Thefe are fufficiently diftin-
guifhed, by having their bodies covered with fcales, and
being without feet or fins. They have a head, noftrils,
ears within the head, only one ventricle in the heart,
and their blood is almoft cold ; they refpire only after
long intervals, and produce eggs, like oviparous quadru-
peds. Serpents have neither neck nor fhoulders. The
fcales with which they are covered, are of three forts :
They are either rhomboidal, and rifing over each other
like tiles,—to which form and difpofition, Linnæus gives
the name of *fquammæ* ; or elfe of an oblong fquare form,
and difpofed one befide another,—and thefe Linnæus
calls *fcuta* or plates ;—when very fmall, and ftill of this
form, they are denominated *fcutella* or fmall plates : Or,
laftly, they form rings, round the body of the ferpent,—
as in the amphifbæna.

Though ferpents be without feet, yet they often move
nimbly enough, by fixing the fore part of the body, raif-
ing the middle, and then bringing forward the hinder
part ; when they reft on the tail, and fpring to a diftance

X 2

to attack their prey.   They change their fkin once or
twice a year.

Some ferpents are venomous.   Of 131 fpecies of
which Linnæus takes notice, 23 are by that naturalift
reckoned dangerous.   All of thefe animals whofe bite is
dangerous, have, on each fide of the upper-jaw, a tooth
confiderably larger than their other teeth ; at the root
of which is a cell filled with a peculiar fluid, which they
pour into the wound through a pipe in the tooth.

It cannot now be confidered as a matter of doubt, af-
ter the teftimony of fo many refpectable authorities,
that there are fpecies of ferpents of a very extraordinary
fize.   M. Adanfon, from a number of very accurate
facts, fixes the fize of the largeft ferpents, at forty or
fifty feet in length, and a foot and an half in thick-
nefs.

Of all naturalifts, M. Laurenti has entered the moft
minutely into the claffification of ferpents.   He diftri-
butes them into 17 genera.   But M. Daubenton rejects
the fyftem of that naturalift, becaufe it is fo exceedingly
difficult to recognize the diftinctive characters ; adopting,
in preference to it, that of Linnæus.——The fixth table,
at the end of this volume, contains the divifions and cha-
racteriftics of ferpents, from genera, to no fewer than
one hundred and twenty-feven fpecies which have been
enumerated by M. Daubenton.

ARTI-

ARTICLE VI.

Of Fishes. ICHTHYOLOGY.

FISHES are a very different fort of animals from thofe
which we have hitherto been confidering : the ftruc-
ture of their internal organs is altogether peculiar, as
will be fhewn in our abftract of phyfiology. They dif-
fer from other animals, in having, inftead of feet, fins
which enable them to move in water,—and in refpiring
water inftead of air. It is much more difficult to gain a
a knowledge of fifhes, than of other animals; and
accordingly, the natural hiftory of fifhes is very im-
perfect.

In order to underftand the methodical divifion of thefe
animals, which we are about to propofe from Artedi,
Linnæus, and M. Gouan, it will be neceffary for the
reader to take a hafty view of the anatomy of the exte-
rior parts of their bodies. The bodies of fifhes may be
divided into three parts : the head, the trunk of the bo-
dy, and the fins.

The heads of thefe animals are of various forms :
—Either horizontally or laterally flattened, or round;
either naked or fcaly ; fmooth, or overfpread with afpe-
rities, tubercles, &c.—The lips have been obferved to

be either flefhy or bony, with appendices or barbels, foft, and very eafily moveable : the teeth are fixed, either to the jaws, the palate, the tongue, or the gullet : their eyes are two in number, motionlefs, and without eyelids : the channels of their noftrils are double on both fides : they have an opening at the gills or bronchiæ : they are provided with bones, either round, triangular, or fquare, to fhut this opening : the bronchial membrane is placed under thefe, and fupported by feveral other bones, in the form of a bow, the number of which varies from two to ten. This membrane folds back on the bones above it ; and it is an object of importance to examine the varieties of its ftructure,—as the characteriftics of genera are often taken from the number or form of the radii.

The form of the trunk varies, as well as that of the head. It is either round, or globular, or oblong, or flat, or angular. In it are to be obferved the lateral lines, which feem to divide each fide of the body into two parts :— The thorax, fituated immediately below the gills, at the upper extremity of the trunk, and filled with the heart and the pulmonary veffels :—the belly, the fides of which extend from the head to the tail, and which contains the ftomach, the liver, the air-bladder, and the genital organs : —the orifice of the anus, common to the inteftines, the bladder, and the organs of generation :—and laftly, the tail, which terminates the trunk, and of which the form and fize are various.

The fins, *pinnæ natatoriæ*, confift of membranes, fupported on fmall radii, of which, fome are hard and bony, and terminate in a thorny point,—which has procured to the fifhes to which it belongs, the name of *acanthopterygii* from Artedi ; others are flexible, foft, obtufe, and feemingly cartilaginous,—and characterife the fifhes

to

to which they belong, as *malacopterygii*. The fins are diſtinguiſhed into five ſorts, according to their ſituations; dorſal, pectoral, abdominal, on the anus, and on the tail.

The dorſal fin maintains the fiſh in equilibrium. It is diverſified by ſituation, figure, number, proportion, &c.

The fins of the thorax are ſituated at the opening of the gills: they are two in number: they ſerve the purpoſe of arms, and ſometimes even of wings: they differ in ſituation, extent, figure, &c.

The fins of the belly are more particularly worthy of notice; for, from their ſituation has the celebrated Linnæus taken his diſtinctive characteriſtics in claſſing fiſhes. Theſe fins are ſituated on the lower part of the body, immediately above the anus, and always lower and nearer each other than the pectoral fins. They are ſometimes wanting; and as Linnæus compares them to feet, he calls ſuch fiſhes as want theſe fins *apodes*. Moſt fiſhes, however, are poſſeſſed of them; but they are not always inſerted at the ſame place. When they are ſituated either before or immediately under the opening of the gills and the pectoral fins, both they and the fiſhes to which they belong, are called *jugular*. When fixed to the thorax, and behind the opening of the gills, they are called *thoracic:* And, in Linnæus's ſyſtem, fiſhes of this ſtructure are diſcriminated by the ſame name. Laſtly, when placed under the belly, and nearer the anus than the pectoral fins, they are called *abdominal;* and, in like manner as before, communicate their name to the order of fiſhes which have them in this ſituation.

The fin of the anus is an odd one: it occupies, either in whole or in part, the region between the anus and

the

the tail. It is liable to varieties of form, number, and fize. Yet, none but the golden-fish of China, are known to have two of thefe fins.

The tail fin is difpofed vertically at the extremity of the body, and terminates the tail. The fifh ufes it as a rudder, moving it, fo as to change the direction in which it fwims, at pleafure. It is likewife fubject to fome varieties in its form, its adherence or connexions, its extent, &c.

After this account of the anatomy of the exterior parts of fifhes, we may pafs to the fyftematic divifions in which naturalifts have arranged them. Before Artedi, no naturalift had attempted a fyftematic arrangement of fifhes; although claffifications of the other animals had been already formed. This philofopher was the firft who offered to the world, a fyftem of ichthyology formed on the nature of the fins, as hard or foft, pointed or obtufe, and on the form of the gills. He afterwards engaged in a defign to extend the divifions by characteriftics taken from other parts; but was prevented by a premature death, from accomplifhing his defign. Linnæus contrived to form a fyftem of ichthyology, on the variations of the pofition of the fins of the belly: And M. Gouan, a celebrated profeffor of Montpellier, has very happily combined the two fyftems of Artedi and Linnæus. This naturalift divides fifhes firft into thofe whofe gills are perfect,—that is to fay, confift of an *operculum*, and a bronchial membrane regularly organized; and thofe whofe gills are imperfect, —that is, who want either the operculum, or the bronchial membrane, or both. The firft mentioned, are thofe diftinguifhed by the form of their fins.—In fact, thefe parts confift either of hard, pointed bones, or of foft, and feemingly cartilaginous radii. Thefe diftinc-

tions

tions eftablifh three different claffes of fifhes: 1. The acanthopterygii; 2. The malacopterygii; and, 3. The bronchioftegi. In each of thefe claffes, the belly-fins being either wanting, or placed on the neck, on the thorax, or on the belly; M. Gouan therefore divides each clafs into four orders: *apodes*, jugular, thoracic, and abdominal.

The diftinctive characters of the genera, under thefe divifions, are taken from the form of the body, the head, the mouth, the bronchial membrane, and more efpecially the radii which fupport that membrane.———*See Table VII.*

ARTICLE VII.

Of *Infects*. Entomology.

INSECTS are diftinguifhed by the form of their body, which feems to be divided into rings; and by two moveable horns on the fore part of the head, called *antennæ*. Infects form one of the moft numerous claffes of animals, on account, no doubt, of their diminutive fize; for it has been obferved, that the fmaller animals are, fo much the more numerous are they. The hiftory of thefe animals is one of the moft agreeable and amufing branches of natural hiftory; perhaps, too, not the leaft ufeful;

for,

for, in profecuting it, many difcoveries may be made, beneficial both to medicine and the arts.

Infects, in their manners, form, habitations, &c. difplay, in miniature, almoft the whole œconomy and characteriftics of other animals. Some infects walk like quadrupeds; others fly like birds; fome fwim, and live in water, like fifhes; and, laftly, fome leap, or trail along, like certain rep-tiles. This analogy might be even traced much farther, by examining, particularly, the ftructure of their extre-mities, mouth, and interior organs, &c.

Infects, confidered as to external appearance, con-fift of three parts: an head, a corfelet or breaft, and a belly.

The form, fize, and pofition of the head, are various. It is fometimes very large in proportion to the bulk of the infect, and fometimes very fmall: it is either round, or fquare, or oblong; either fmooth, or overfpread with fmall holes, or tuberculated, or covered with hair in certain places. On it are obferved, 1. The antennæ, placed near the eyes, and confifting of feveral different, articulated, moveable pieces, like a thread, terminating either in a point, or in a mafs: the form of the antennæ is to be always carefully obferved; for it affords by its varieties, generic characteriftics: 2. The eyes, which are of two forts, either with facets, or in a fort of net-work, fmooth and fmall: thefe organs are fometimes very large, and fometimes fmall; their number varies: fome infects have only one eye, and are diftinguifhed as monocular; others, fuch as the fpider, have two, five, or even eight: 3. The mouth, which confifts either of fhort, corneous jaws, placed laterally, and moveable towards the fides; or of a probofcis, either longer or fhorter, dilated or fpiral, &c.; or of a fimple gap or orifice, &c. This part is often armed with fmall moveable appendi-ces,

ces, denominated antennulæ or barbels, and either two
or four in number.

The corfelet is the breaft of the infect, placed be-
tween the head and the belly. It is fometimes round,
fometimes triangular, cylindrical, broad, narrow, &c. It
is to be confidered as a fort of cube confifting of fix
fides ; and its form is fometimes regularly cubic. The
front, or anterior extremity, is hollowed for the recep-
tion of the head. In flies, for inftance, the juncture of
the head to the body, at this part, is fometimes formed
merely by a thread. The under extremity, again, is
commonly round, and articulated with the firft ring of
the belly ; fometimes it is joined to that part by a thread.
The upper facet is fometimes flat and fmooth, fometimes
round, prominent, bearing appendices, tuberculated, and
terminating in a jutting border : This forms what is call-
ed the bordered corfelet, *thorax marginatus.*— The
wings are faftened to the pofterior part of this facet. It
is well known, that moft infects are provided with wings;
but that their wings differ amazingly from each other.
It may be of confequence, briefly to confider thefe diver-
fities of the ftructure of the wings of infects ; as natu-
ralifts have eftablifhed on them the leading divifions
of their claffifications of thefe animals.

The wings of infects are either two or four in number.
Infects having two tranfparent wings, fuch as the fly, the
gnat, &c., have always, towards the part where the
wing joins the body, and under it, a fmall filament ter-
minating in a round button, called the *balance ;* and
covered with a concave, membranous appendage, called
the *bowl.* In many infects, thefe two wings are very
ftrong, twifted and plaited under hard, corneous, move-
able fheaths, called *elytra.*—Thefe fheaths are of various
forms : fome of them cover the whole belly ; others are
<div align="right">cut</div>

cut tranfverfely, and cover only a part of the belly: fome of them are hard; others foft: moft of them have, near the place of their junéture, a fmall triangular piece foldered to the corfelet, which is called *fcutellum*; others want this fmall piece. Laftly, a number of infeéts with fheaths, have the elytra foldered fo as to form feemingly but one piece, and motionlefs.

The wings are often four in number; they are then either membranous and tranfparent, as in the dragon-fly, the wafp, &c. or apparently fprinkled with a co-loured duft, which, when viewed through the micro-fcope, proves to be fcales rifing one over another, on the wing, as tiles on the roof of a houfe, *imbricatim*.

The lower part of the corfelet is irregular in its form: it confifts of feveral pieces glued one over another, and bears a part of the legs.—The number of the legs va-ries: Many infeéts have fix legs; and others, fuch as the fpider, have eight legs: fome, again, have ten, like crabs; and laftly, there are fome which have a ftill greater number. Wood-lice are obferved to have fix-teen; and fome fpecies of the fcolopendra have from feventy to one hundred and twenty on each fide. According to M. Geoffroy, the legs of thofe in-feéts which have only fix or eight, are fixed to the cor-felet; but fuch as poffefs a greater number, have a part of them inferted in the rings of the belly.

The leg of an infeét confifts always of three parts:— the thigh—the part next the body, the leg, and the tarfus. Befides thefe, there is often an intermediate piece between the body and the thigh. The tarfus con-fifts of feveral pieces or rings articulated one with ano-ther: the number of thefe rings varies from two to five. There are even fome infeéts which have the tarfus lar-ger in the fore, than in the hinder legs; which efta-
blifhes

blifhes an analogy between the ftructure of thefe fmall animals and that of many quadrupeds, which have more toes on the fore than on the hinder feet. M. Geoffroy, as we fhall afterwards fee, has affumed a part of this character for the bafis of his fyftematic divifion of infects. The tarfus is terminated by two, four, or fix fmall claws, and has generally, on the under fide, feveral fmall brufhes, or fpongy clues, which enable the infect to adhere even to the moft polifhed bodies, fuch as ice, &c.

On each fide of the corfelet, there are obferved, one or two oblong, oval apertures, called ftigmata, by which the infect refpires.

The third part of the body of an infect, is the belly. It generally confifts of corneous rings, or half-rings, incafing one another. Sometimes, no fuch rings are obferved, but the belly appears to confift all of one piece. Female infects have ufually larger bellies than the male. At the extremity of the belly, are the parts of generation : On the fides, each ring but the two loweft is perforated with a ftigma. At the lower part of the belly, too, many infects bear their ftings ; of which, fome are fharp-pointed, others ferrated, and others of an auger form.——They ufe them as weapons of defence, and as inftruments for forming cells in which they may depofite their eggs.

The moft fingular phænomenon which infects exhibit, —which, more than any thing elfe, diftinguifhes them from moft other animals,—is, their paffing through different ftates by a fort of metamorphofis, before they become perfect infects. Some infects,—almoft all thofe belonging to the clafs of *aptera*, fuffer no fuch changes ; but by far the greater number of thefe animals are fubject to them. The infect is not of the fame form with its parent, when it iffues from the egg ; it is then a

worm,

worm, either with or without legs; and, in this state, these animals exhibit great diversities in the head and the rings.　In this first state, the insect receives the name of *larva :* under this mask, it eats, grows bigger, moves, and changes its skin several times.　When it attains its full size, it changes its skin for the last time; and is now no longer a worm or larva, but in a totally different form; in which it is known by the names, *nympha, chrysalis, aurelia.*

M. Geoffroy distinguishes *nymphæ* into four different species.—The first bears no resemblance to an animal.— Only a few rings are observed on its under part; and above, only some very imperfect marks of antennæ, legs, and wings.—The skin of this species of nymphæ is hard and cartilaginous; and only some of its rings are moveable.—Such are the nymphæ of butterflies, &c.

The second species of chrysalis exhibits the parts of the perfect animal, wrapped in a very thin soft skin.— Like that of the former species, it is immoveable.　Insects with cafes, insects with four naked wings, and insects with two, pass through this state.

The third species displays the parts, fairly unfolded, very conspicuous, and moveable.—Such are the chrysalides of gnats, and insects which, in the first states, pass their life under water.

Lastly, the fourth species consists of those which, in the form of the body, their legs, and antennæ, resemble the perfect insect.　These nymphæ walk and eat: the only difference between them and perfect insects, is, that they want wings, and are incapable of generation.—The nymphæ of the dragon-fly, the bug, the grashopper, and the cricket are of this sort.

Insects, like other animals, were not distinguished by ancient naturalists otherwife than by the situations in which
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they inhabited. Before Linnæus, no philofopher had attempted a fyftematic arrangement of them, in which they might be diftinguifhed by certain characters.—The firft claffification of infects was formed by that naturalift. After him, M. Geoffroy attempted a more accurate claffification of them.—His divifion of infects into fections and genera, is a mafter-piece of precifion and perfpicuity : It is this naturalift's fyftem which we have adopted. M. Fabricius has fince attempted a divifion of infects, by the form of the jaws.

M. Geoffroy divides infects into fix fections, according to the number, the ftructure, or the want of the wings. The firft fection contains *coleoptera*, or thofe infects which have their wings covered with cafes. Their mouth is formed by two lateral and corneous jaws, and is the fecond general characteriftic of this fection. The May-bug difplays thefe two characteriftics.

The fecond fection, the *hemiptera*, whofe upper wings are either fomewhat thick and coloured, or half hard and opaque ; but in this fection, the wings do not afford fo certain and confpicuous a characteriftic as the mouth. The mouth is a long, acute trunk, which terminates, below, between the legs. To this fection belong the wood-bug, and the balm-cricket.

The third fection confifts of *tetrapterous infects with mealy wings*, whofe four wings are coloured by a fcaly duft, which have a trunk, fometimes longer, fometimes fhorter, frequently fpiral ; as, for inftance, the butterfly. Linnæus calls thefe infects *lepitoptera*.

The fourth fection confifts of *tetrapterous infects having naked wings*. Their four wings are membranous : they have hard jaws.—Such is the wafp. Linnæus has divided thefe infects into two orders : The *nevroptera*, which have no fting on the anus, and have their wings

divided

divided by nerves; and the *hymenoptera*, which have no fting at the anus, and have membranous wings, but no very difcernible nerves in them.

The fifth fection confifts of *dipterous* infects, or infects with two wings. Their mouth is generally of a trunk form; and, at the root of the wing, they have fmall buttons, ferving as balances, and bowls covering them.

Laftly, in the fixth and laft fection, are ranked the *aptera*, infects deftitute of wings, fuch as the fpider, the loufe, &c.

Befides thefe primary divifions, M. Geoffroy has eftablifhed fome others, to affift the collector of infects.——— (*See Table VIII.*)

Although feveral celebrated naturalifts have, fince M. Geoffroy, turned their attention on the hiftory of infects; and although M. Fabricius has publifhed a new fyftem of the claffification of infects, in which the characteriftics are taken from the organs with which they receive their food; yet I have preferred M. Geoffroy's fyftem, which, as it contains fewer genera and fpecies, is far from being fo complicated and perplexing as that of M. Fabricius.

ARTICLE VIII.

Of Worms. HELMINTHOLOGY.

WORMS are foft animals, very different in form from infects, with which they have been, by many naturalifts, confounded, and far from being fo perfectly organized.

organized. They have, properly fpeaking, no mouth ; —the conformation of their members does not refemble that of infects, nor are they liable to pafs through different ftates. Few of them are known to have organs for generation : Moft of them have no head, regularly formed ; and they are all diftinguifhed by the want of feet and fcales.

The clafs of worms is the moft numerous, and the leaft known of all the claffes of animals.—There are few organized bodies, either dead or living, in which worms are not found. Moft naturalifts have arranged worms and polypi under one clafs. They might perhaps be better feparated ; as they are widely different in refpect to their interior ftructure and habits. Moft worms have a heart and blood-veffels ; but no fuch organs have been obferved in polypi.

The worms on which our attention is at prefent engaged, are to be carefully diftinguifhed from the larvæ of infects, which have likewife received the name of worms on account of their form. Their head has a jaw ; their legs are more or lefs numerous, but generally about fix ; and thefe parts afford characteriftics by which they may be diftinguifhed.

Worms are very much difpofed to motion : moft of them are fond of moifture, and feek after it. In fome, the form of the head is not very perfect ; and they are moftly hermaphrodites.—Such as have heads, have upon them two moveable horns, which they can draw inwards, and which are called *tentacula.* It appears, that almoft all worms, when mutilated, reproduce the parts which they lofe.—This fhews their organization to be very fimple ; and in this particular, they refemble polypi.

This clafs of animals may be divided into four fections : —The firft containing naked worms, the organization of

which is beft known, and which, in this property, near-
ly refemble other animals.——In the fecond fection, we
may arrange worms with a teftaceous covering,——fhell-
worms. The organization of thefe is not fo well known
as that of the former clafs ; but M. Adanfon's refearch-
es have fhewn their ftructure to be nearly the fame with
the ftructure of naked worms.——The third fection may
comprehend worms having a cruftaceous covering. Of
thefe, the organization is lefs known than that of either
of the two preceding fections ; nothing but their exter-
nal form, and the ftructure of their mouth having been
yet examined.——The polypi belong to the fourth fection.
——Many naturalifts have already employed themfelves on
the fyftematic divifions of thefe different fections. In the
divifion in the eighth table, we have followed Lifter,
Linnæus, Klein, Ellis, Pallas, D'Argenville.————(*See Ta-
ble VIII.*)

SECTION II.

Of the Functions of Animals, from Man to the Polypus.

THE characteristics of living, organic bodies are, as we have already observed several times, the different functions which they perform with their organs. These we have confidered in vegetables; and, the order which we have obferved, requires us to confider them alfo in animals.

The department of medicine to which it belongs to examine the functions of animals, is Phyfiology. This valuable fcience fhould not be confined to man; it fhould be extended to all animals: And in this light are we going to take a hafty view of it at prefent.

The

The functions of animals may be reduced to the following:

1. Circulation.
2. Secretion.
3. Respiration.
4. Digestion.
5. Nutrition.
6. Generation.
7. Irritability.
8. Sensibility.

These different functions belong to man, quadrupeds, cetaceous animals, birds, oviparous quadrupeds, serpents, fishes, insects. Worms and polypi are not capable of them all; and the other classes display them in different degrees.

ARTICLE FIRST.

Of Circulation.

CIRCULATION is one of the first functions of animals: it is the function by which life is maintained: when it ceases, the animal immediately dies: the organs employed in it are the heart, the arteries, and the veins.

The

The heart is a conical mufcle, with two cavities in its bottom, which are called *ventricles.* Immediately under it are two bags, called *auricles.* Out of the left ventricle, there proceeds a large artery, which is called the *aorta,* and diftributes the blood through the whole body. Another artery, equally large, likewife proceeds from the right ventricle : this is called the *pulmonary artery,* becaufe it fpreads, in ramifications, through the lungs. The right auricle receives the blood as it returns from its circulation through the whole body, by the two *venæ cavæ.* This fluid paffes from the right auricle into the right ventricle. From the right ventricle, it iffues into the lungs, through the pulmonary artery. Through the pulmonary veins, it proceeds into the left auricle : it paffes thence into the left ventricle ; and from the left ventricle, by the aorta, through the whole body.

This motion, which proceeds in this manner in the human body, forms two forts of circulation ;—circulation through the whole body, and the circulation in the lungs. The latter was known before the former. The general circulation was difcovered by Harvey, an Englifh phyfician.

In quadrupeds, cetaceous animals, and birds, this function is carried on precifely in the fame way as in man. In fifhes, the heart has only one ventricle ; and, in them, the lungs, or gills, do not receive the blood through a particular cavity in the heart. In reptiles, this function is performed in the fame way as in fifhes. In infects and worms, the heart confifts of a feries of knots, which contract, one after another : their veffels are very fmall, and their blood cold and colourlefs. Polypi have neither a heart nor blood-veffels : In them, this function is

carried

carried on in a more imperfect manner than even in vegetables.

ARTICLE II.

Of Secretion.

SECRETION is a function by which there are separated from the blood, in different organs, juices designed for particular purposes, such as the bile in the liver, &c. This function is one of the most general among animals : it takes place through all the classes ; but we cannot describe it as it is performed in them all, without running into too tedious a detail of particulars. We shall only observe, therefore, that, in all animals in which a real circulation is carried on, secretion is regulated by the same laws as in the human species ; and appears to take place even in most of those animals which have no heart. Besides that analogy which must necessarily subsist between man and such animals as are possessed of the same organs, in respect to the function of which we are now speaking ; almost every different class of animals has peculiar secretions which are not observable in the human species :—such are the secretions of musk and civet, among quadrupeds ; of the white of the whale, and ambergrise, among cetaceous animals ; of the

the oily juice with which birds drefs their feathers ; of the virulent humour of the viper ; of the glutinous fluid of the fcales of fifhes ; of the acid and acrid juices of the bupreftes, ftaphylini, ants, and wafps, among in-fects ; of the vifcid mucilage of fnails ; of the colouring juices of purple ; and of many others, which come to be taken notice of under the natural hiftory of the different fpecies of animals.

ARTICLE III.

Of Refpiration.

RESPIRATION, confidered as it takes place in all ani-mals in general, is a function which brings the blood into contact with the fluid in which they live. For this purpofe, man and quadrupeds are poffeffed of an organ called the *lungs.*—It is a collection of hollow veficles, which are nothing more but ramifications of a membranous and cartilaginous duct, called the *tracheal artery,*—and of the blood-veffels, which, with their rami-fications, form a great many areolæ on the furface of the pulmonary veficles. Thefe veficles and veffels are fup-ported by a loofe and fpongy cellular texture, which forms the parenchyma of the lungs. The air, when

inhaled,

inhaled, diftends thefe vesicles. The oxigene of the atmofphere combines with the carbone difengaged from the blood; and thus forms carbonic acid, which, toge-ther with azotic gas, is exhaled. The matter of heat, fepa-rated from the vital air of the atmofphere, combines with the blood, and reftores to it the properties which it has loft by circulation through the body.

In cetaceous animals, this function is peformed in the fame manner : Only, as in thefe animals there is a di-rect communication between the two auricles, they are capable of remaining for fome time without refpira-tion.

In birds, refpiration is performed much in the fame way as in the above mentioned animals ; but its influ-ence extends much more through the body. Anatomifts have difcovered, in the belly of birds, fpongy veficular organs, which communicate with their lungs ; and the lungs again extend to the bones of the wings,—which are hollow, but contain no marrow,—by a duct which rifes from the upper part of the breaft, and opens into the upper and inflated part of the os humerus. This noble difcovery, which was made by M. Campen, fhews, that the air paffes from the lungs of birds into the bones of their wings. And this fluid being rarefied by the heat of the body, renders them very light, and contri-butes greatly to their flying.

Fifhes have, inftead of lungs, gills or bronchiæ. Thefe organs confift of membranous fringes, difpofed on an arcuated bone, and full of blood-veffels. Water en-ters by the mouth, paffes among the fringes, feparating them from one another, preffes upon, and agitates the blood, and paffes out by two lateral apertures behind the head, on which are two moveable offeous valves, called *opercula*, fupported by the bronchial
　　　　　　　　　　　　　　　　　　　　membrane.

membrane. Duverney imagined that the gills feparated the air contained in the water. M. Vicq d'Azir, who has employed himfelf a good deal on the anatomy of fifhes, is of opinion, that, in their gills, water acts tlie fame part which air does in the lungs of other animals. One thing certain is, that, as thefe animals do not refpire air, or produce from it carbonic acid, their blood is not of the fame degree of heat which that elaftic fluid communicates to the blood of animals which refpire it.

Infects are deftitute of lungs. They have two ducts, or trachex, extending along the back, with which, on each fide, a number of other fmaller ducts communicate; and thefe terminate, one on the outer fide of each ring, by fmall orifices, called *ftigmata*. The ftigmata rather appear to be defigned for the expiration of a particular elaftic fluid; for infects do not die immediately in vacuo; but when the ftigmata are clofed up, they are thrown into convulfions, and die in a few feconds. The organization of worms is ftill more imperfect. Polypi are not known to refpire at all: in this function, therefore, they are more imperfect than vegetables, in which trachex have been found.

ARTI-

ARTICLE IV.

Of Digeſtion.

DIGESTION is the ſeparation of the nutritious mat-
ter contained in food,—and its abſorption by certain
veſſels, called *chyliary.* It takes place in a duct running
between the mouth and the anus, which, in the human
body, is dilated towards the upper part of the abdomen.
The part dilated, is. called the *ſtomach*, or ventricle.
The alimentary canal then becomes narrower, and is
wound into what are called the *inteſtines.* This long
tube, conſiſting of muſcles and membranes, is intended
to detain the aliments till all the nutritious matter be ex-
tracted from them. There are alſo other glandulous or-
gans ſituated round the ſtomach, the purpoſe of which
is to prepare fluids for ſtimulating the ſtomach and in-
teſtines, and to extract the nutritious part of the ali-
ments. Theſe organs are the liver, the ſpleen, and the
pancreas. The bile and the pancreatic juice run into
the former inteſtine called the *duodenum,* and mix with
the aliments: Before that mixture takes place, the
aliments are diſſolved in the ſtomach by the gaſtric
juice.

The

The primary inteſtines, through their whole length, are filled with the orifices of veſſels, the buſineſs of which is to carry off the chyle. Thoſe veſſels convey it into the lumbar, and the thoracic duct; and the chyliary fluid is thus diſcharged into the left ſubclaviar vein; where it mixes with the blood.—Such are the mechaniſm and the phænomena of digeſtion in the human body.

Quadrupeds differ widely from one another, in the form of their teeth, ſtomach, and inteſtines. Some of theſe animals, as, for inſtance, the philodotus and the ant-eater, are without teeth, and eat nothing but ſoft aliments. Others, ſuch as the tatou and the ſloth, have only the *molares.* Some, ſuch as the elephant and the ſea-cow, have both the molares and the canine teeth. Laſtly, moſt quadrupeds have three ſorts of teeth—molares, canine, and inciſory. What is moſt ſtrikingly remarkable in the diverſified ſtructure of the teeth, as has been remarked by Ariſtotle, Galen, &c. is, that there exiſts, invariably, a relation between the number and poſition of the teeth, and the form of the ſtomach. All quadrupeds having inciſory teeth in the two jaws,— the horſe, the ape, the ſquirrel, the dog, the cat, &c., have only a membranous ventricle, like that of the human ſpecies. Anatomiſts call theſe animals *monogaſtric.* In them, the function of digeſtion is performed in the ſame way as in the human body.—Quadrupeds having inciſory teeth only in the under jaw, are *polygaſtric* and ruminating,—ſuch are the camel, the camelopardalis, the buck, the ram, the cow, the ſtag, and the kid. Theſe quadrupeds are generally bifulcar and horned; they have, all of them, four ſtomachs. The firſt is called, in the cow, the *paunch :* it is the largeſt, and is divided into other four bags. It, together with the ſecond,

cond, which opens into the paunch by a large orifice, receives the aliments.—In theſe organs, herbaceous aliments are dilated, and air rarefied : theſe ſtimulate the nerves, and thus produce an anti-periſtaltic motion, which throws them back into the œſophagus and the mouth, where they undergo a new comminution by the dentes molares ; and being reduced into a ſort of ſoft paſte, they are again ſwallowed, and, together with the drink of the animal, conveyed into the third ſtomach, the *omaſus*, through a ſemi-canal extending between the œſophagus and that ventricle.   Laſtly, from the omaſus they are conveyed into that ventricle, which, in calves, is called the *rennet-bag*, and there thoroughly digeſted.—The inteſtines of ruminating animals are alſo much larger than thoſe of monogaſtric quadrupeds. The mechaniſm with which cetaceous animals are provided for this function, is exactly like that of monogaſtric quadrupeds.

Birds differ from one another in the ſtructure of the ſtomach : in ſome, it is membranous,—in others, muſcular.   Thoſe poſſeſſed of the former characteriſtic, which may be called *hymenogaſtric*, are carnivorous : All birds of prey belong to this ſpecies. Their ſtomach contains a very powerful juice, capable even of reducing bones to a ſoft ſubſtance, according to Reaumur's experiments : their bile is likewiſe very acrid.—The ſecond, which merit the name of *myogaſtric*, live only upon grain : their ſtomach conſiſts of a quadrigaſtric muſcle, covered with a hard, thick membrane, ſuitable for trituration.   Theſe birds have likewiſe a double cæcum.

Fiſhes have a membranous ſtomach, of an oblong form, with a good many appendices : their inteſtines are generally ſhort. They have a liver, but no pancreas. —Reptiles

—Reptiles diſplay the ſame internal ſtructure: their ſtomach is capable of an amazing diſtenſion. Serpents have been often ſeen to ſwallow whole animals, much larger than themſelves.

Inſects have a ſtomach and inteſtines, regularly organized. Swammerdam and Perrault affirm, that a particular ſort of cricket has four ſtomachs;—that is, one large ſtomach divided into four bags, as appears when the animal is diſſected.—The ſtomach of worms is very irregularly formed: they have alſo ſmall inteſtines.— The polypus ſeems to be nothing but ſtomach; for it digeſts very faſt. The ſame orifice ſerves it both for mouth and anus.

ARTICLE V.

Of Nutrition.

NUTRITION is the conſequence of digeſtion and circulation. As the ſolids are always ſuffering a loſs by the motions which they carry on, they need to be repaired; and this reparation they receive from the function of nutrition.—In the firſt period of the life of the animal, they grow larger; and the animal increaſes in ſize. The cellular tiſſue is uſually conſidered as the organ of this function, and the lymph as the humour

from

from which the folids derive that reparation which they need. It appears, however, that each organ is nourifhed with a matter peculiar to itfelf, which it feparates either from the blood or from the lymph, or from fome other fluid. The mufcles, for inftance, are nourifhed by a fibrous matter which they feparate from the blood: the bones extract from it a calcareous phofphoric falt, and a lymphatic matter; the pure lymph dries into plates in the cellular texture: concrefcible oil, depofited in thefe, produces the fat. Every different part of the body is nourifhed in a way peculiar to itfelf: the nutrition of each of thefe parts is truly an act of fecretion. This function is carried on in quadrupeds and cetaceous animals, precifely in the fame way as in man: In birds, ftill in the fame way; in fifhes much flower,—and they therefore live very long. In general, the flower the nutrition and growth, the longer is the life of the animal.

There is nothing peculiar in the manner in which this function is carried on in infects. They grow only in the form of larvæ; but not when chryfalides or perfect infects. Swammerdam and Malphigy have fhewn, that the larva contains the perfect infect, fully formed, under a number of fkins;—the caterpillar inclofes the butterfly, with its feet and wings folded.

In worms and polypi, nutrition is carried on in the cellular tiffue; and in vegetables, likewife, by means of the cellular and veficular tiffues.

ARTICLE VI.

Of Generation.

GENERATION, confidered through the whole animal kingdom, is performed in many various ways. In moft genera there is a diftinction of fexes, and copulation is requifite for the production of the fpecies ;— fuch, for inftance, is the law with refpect to man, quadrupeds, and cetaceous animals.

The females of quadrupeds have a matrix parted into two cavities, *uterus bicornis,* and a greater number of teats than the female of the human fpecies : they are not fubject to the menftrual flux : moft of them produce feveral young at one time, and the period of their geftation is commonly fhorter. Several of them have a particular membrane, for receiving the urine of the fœtus : it is called *allantoides.*

The manner of generation, in birds, is very different. The males have a very fmall genital organ, not perforated, and often double. In the females, the vulva is ufually fituated behind the anus : they have ovaria, but no matrix, and a duct through which the egg is conveyed from the ovaria into the gut : this duct is called the *oviductus.* Phyfiologifts who have examined the phæ-

nomena

nomena of incubation, have obferved fome unexpected facts with refpect to the egg, both fecundated, and not fecundated. Malphigy and Haller have made the moft important of thefe difcoveries. Haller found the pullet fairly formed in eggs not fecundated.

Copulation does not take place among fifhes. The female depofites her eggs on fand, and the male paffing over them, impregnates them with his feminal liquor, which is no doubt neceffary for their fecundation. After a certain period, thefe eggs burft, and emit the young fifhes.

The males of various fpecies of oviparous quadrupeds have a double or forked organ for generation. Of ferpents, the viper is the only viviparous fpecies.

Infects alone difplay all the varieties with refpect to this function that are obfervable among other animals : fome fpecies exhibit the diftinction of fexes among individuals,—this, indeed, is the cafe with the greateft number : in other fpecies, reproduction takes place either with or without copulation,—as in the vine-fretter : an infect of this fpecies, inclofed by itfelf in a glafs, produces a great number of young. M. Bonnet has fully eftablifhed the truth of this fact, by a feries of experiments profecuted with the utmoft care. The genital organ of male infects is concealed in the belly. When the extremity of that part of the infect's body is gently preffed, the organ appears. It is ufually accommodated with two fmall arms for holding the female. The fituation of this organ is very much varied : it is fometimes on the upper part of the belly, near the breaft,—as in the female of the dragon-fly, *libellula ;* at other times, it is fituated at the extremity of the antenna,—as in the male fpider. Infects multiply prodigioufly, and are almoft all oviparous, excepting the wood-loufe.

Worms

Worms are androgynous: every individual poffeffes the characteriftics of both fexes; and copulation is double,—as may be obferved of the earth worm and the fnail.

M. Adanfon adds, that bivalvular fhell worms are deftitute of organs of generation, and reproduce the fpecies without copulation. Thefe worms are viviparous. —Univalvular fhell worms are oviparous: the young, whether they iffue from an egg, or immediately from the belly of the mother, have the fhell ready-formed from their birth.

Polypi are the moft fingular animals with refpect to generation. They produce by fhooting off flips.—When a polypus attains its full growth, it fhoots out, as it were, a fmall branch, which is feparated from it, and fixes on any contiguous body; where it continues to grow till it have nearly gained its full fize. Polypi, in fhort, are produced from one another, much in the fame way as branches fpread from the trunks of trees.

We know only the more apparent phænomena of generation.—All the fyftems which have been formed to explain that myfterious operation of nature, are attended with infuperable difficulties. Accounts of them may be found in Haller's Phyfiology, Maupertuis's *Venus Phyfique*, and Buffon's Natural Hiftory.—M. Bonnet, in his Reflections on organized Bodies, has faid more on this fubject than almoft any other perfon.—Buffon's fyftem is ingenious, and deferves to be read.

ARTICLE VII.

Of Irritability.

IRRITABILITY is a property of certain organs, called *mufcles*, by virtue of which they contract, when acted upon by the contact of any ftimulus.—M. Haller has given a very good account of the doctrine of irritability.—The mufcles of man, quadrupeds, cetaceous animals, and birds, refemble each other. They are all equally red, and confift of fibres united in bundles of different forms, covered with filver-coloured membranes called *aponeurofes*, and terminating in flat or round cords called *tendons*.

The mufcles of fifhes are white, and much more irritable than fuch as are red.—The mufcles of oviparous quadrupeds and ferpents are ftill more irritable; and in thefe animals the irritability remains long after the death of the animal. This laft property appears to be common to all cold-blooded animals; but thofe whofe blood is hot, feem to lofe the irritability of their mufcles as it becomes cold.

The mufcles of infects are within the bones, which are hollow and of a corneous nature. This ftructure is very difcernible in the thigh-bone of the great green grafhopper, and alfo in the crab.

The mufcles of worms are very pale and irritable: they are even very ftrong,—efpecially in thofe worms which have a ponderous fhell to move.

Polypi

Polypi are very irritable : they contract into a round point ; they move their arms with amazing agility, and fold them very readily. Their ſtructure, however, does not appear to be muſcular.

It is their irritability which renders animals capable of moving from one place to another, and performing ſuch motions as are neceſſary, that they may remove hurtful things to a diſtance, and procure what they need. The hiſtory of theſe motions is therefore refer‑ able to the hiſtory of this function. Standing and walk‑ ing, leaping, flying, the pace of reptiles, and ſwimming, are a combination of actions which depend on the muſ‑ cular contractions of animals. Were we to enter into a minute detail of them, it would be neceſſary to conſider, in the human ſpecies, with reſpect to ſtanding,—the muſcles which ſerve to extend the thigh ; with reſpect to leaping,—the extremities, the form of the body, the length and acuteneſs of the countenance, and the lateral compreſſion of the thorax, in quadrupeds ; with reſpect to flying,—the ſtructure of the feathers, the breaſt‑ bone, the pectoral muſcles, the bill, the tail, and the in‑ terior texture of the bones, in birds. It would be no leſs neceſſary to conſider the muſcular rings, and the ſcales or tubercles which reptiles have inſtead of feet ; in fiſhes, the form of the body, the ſtructure of the fins, the ſtructure of the air-bladder, and its communication with the ſtomach ; in inſects, the ſtructure, the number, and the poſition of the legs, the appendices of the tarſi, the form, the poſition, and the nature of the wings, and of thoſe organs which nature has given them to balance themſelves in the air, &c. But it is enough for us at preſent to have pointed out the importance of ſuch re‑ ſearches, and that they are highly worthy of the atten‑ tion of the phyſiologiſt.

Laſtly,

Laftly, there is another confideration which does not appear to me to have been hitherto properly attended to.—Mufcles may be confidered as organs of fecretion, intended by nature for the feparation of the fibrous and irritable matter of which we have elfewhere fpoken. The diforders to which this fort of fecretion is liable, fhould be carefully obferved by phyficians. We have already had occafion to treat of this in our account of the blood.

ARTICLE VIII.

Of Senfibility.

SENSIBILITY is a function, by means of which animals are fufceptible of pleafure and pain, according to the refpective natures of bodies in contact with their organs. Senfations depend on the brain, on the marrow, on the fpine, and the numerous nerves which are diffufed from thefe parts, all over the body : without thefe organs, there could be no fenfibility. In order the better to explain the nature of this function, we may divide into three regions thofe organs which appear to form only one whole ; which phyfiologifts have called the *fenfible man.* Thefe three are, the brain, the hinder part of the brain, and the fpinal marrow,—the nerves diffufed from thefe parts over the body,—and the fenfitive expanfion, or dilated extremity of the nerves. This extremity or expanfion exhibits a great diverfity of forms in the different organs : it is fometimes membranous and reticular,—as in the ftomach and the inteftines ; fometimes foft and pulpy,—as at the bottom of the eye, and within the labyrinth of the ear. Under the fkin, on the tongue, on
                                                              the

the top of the glans, &c., it takes a different form ; and in other places,—as on the nafal membrane of Schneider, it is fpread out in long filaments, foft and flat.

The brain of the human fpecies is larger, and better organized than that of any other animal : it is the feat of thought. In quadrupeds, it is much fmaller ; but their nerves are more fenfible ; and their fenfes, particularly the fenfe of fmelling, more acute,— the organ of this fenfe being very much dilated, and, as it were, multiplied, by the number of the ethmoidal plates. The fkin being thick, and covered with hair, is, on that account, not poffeffed of great fenfibility. The tafte of thefe animals is very delicate.

The brain of cetaceous animals is exceedingly fmall, in comparifon with the fize of the body : it is encompaffed by a thick, oily fluid : their fenfes are obtufe.

The brain of birds is not of the fame ftructure, nor has it the fame folds, convexities, and concavities with that of the human fpecies and quadrupeds. The beautiful ftructure of the eyes of thofe animals ; their thick and cartilaginous fclerotica ; the *membrana nictitans,* or interior eye-lid, moved by particular mufcles ; the bulk of the cryftalline and vitreous fubftances ; the bag of black matter, at the extremity of the optic nerve ; the brilliant cruft which coats the choroides ;—all thefe together, difplay a very complicated organization, and fhew, that nature has taken extraordinary pains to render the powers of vifion of thefe animals keen and piercing ; and thus enable them to diftinguifh their prey at a diftance, and avoid the dangers to which they are expofed by the rapidity of their motion in flying : In a word, to favour the agility and activity of motion, which feem to be the peculiar prerogatives of thefe animals. Their hearing is not fo perfect as their fight. They do not appear very

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capable

capable of diftinguifhing either the tafte or the fmell of
aliments. The fituation of the noftrils, and the hard
membrane which covers the bill, account for thefe phæ-
nomena.

Reptiles have but very little fenfibility. Their brain
is very fmall : there are no knots on their nerves : their
fenfes, in general, appear to poffefs but very little acti-
vity. Yet Meffrs Klein, Geoffroy, and Vicq d'Azyr,
have obferved the internal ftructure of both the eye and
ear of thefe animals to be extremely beautiful and regu-
lar.

The brain, in fifhes, is very fmall ; and the cranium
is filled with a mafs of oily matter. Their fenfes, efpe-
cially thofe of fight and hearing, are very acute. The
conformation of the organ of hearing, in fifhes, is very
regular,—as has been obferved by Meffrs Klein, Geof-
froy, Camper, and Vicq d'Azyr.—Thofe naturalifts who
took fifhes to be deaf, were miftaken.

Infects have no brain ; but they have fpinal marrow,
of a cylindrical form, and full of knots, which runs
through the whole length of the body. Nervous fila-
ments fpread out from that marrow, and accompany the
diftribution of the tracheæ.—Of the organs of fenfation,
none but the eyes are known in infects. Swammerdam
defcribes an optic nerve, under the cornea of the eyes
of infects that are reticulated, which is there diftributed
into filaments equal in number to the membranes of the
reticulum. We know not whether they have an organ
of hearing.

The organs of fenfation which have been obferved in
worms, are fcarcely more numerous. Swammerdam
found in the fnail, a brain with two lobes and move-
able,—eyes, fometimes at the bafe, fometimes on the
top of the tentacula,—and an optic nerve, capable of
                                                    contraction

contraction as well as thefe horns. M. Adanfon tells us, that the eyes are fometimes wanting in worms, or at leaft covered with opaque fkin.

As to polypi; they have no organs of fenfation, and yet they feem to have a fort of predilection for light.

Man, therefore, poffeffes the function of fenfibility in a much more eminent degree than any other animal. This is what peculiarly diftinguifhes him, and entitles him to be ranked at the head of the animal creation. —The legiflator, the philofopher, and the phyfician fhould be intimately acquainted with every particular relative to this function.

Z 4 *SUPPLE-*

SUPPLEMENT

TO THE

MINERAL KINGDOM.

Of the Nature of Mineral Waters, and the Methods of analysing them.

AFTER having confidered all the bodies belonging to the mineral kingdom, and examined their phyfical properties, it feems proper to introduce, in this place, the hiftory of mineral waters ; for, as thefe fluids generally hold, in folution, terrene, faline, and metallic matters, either together or feparately, it would have been impoffible to make the reader underftand their nature and compofition, without making him previoufly acquainted with the nature of the principles by which they are mineralized. Another advantage arifing from our introducing, in this place, the account of mineral waters, is, that it may here ferve as a fort of recapitulation of what has been faid of minerals in general ; as their principles muft be taken notice of, in confidering the manner of analyfing them.

§ I.

§ I. *Definition and History of Mineral Waters.*

WATERS holding minerals in folution, are called *mineral waters.* But as all water, in a natural ftate, is impregnated, either more or lefs, with fome mineral fubftances, the name, *mineral waters,* fhould be confined to fuch waters as are fufficiently impregnated with mineral matters to produce fome fenfible effects on the animal œconomy, and either to cure or prevent fome of the difeafes to which the human body is liable *. On this account, thefe waters might be, with much more propriety, called *medicinal waters,*—were not the name by which they are commonly known too firmly eftablifhed by long ufe.

The firft knowledge which mankind acquired of mineral waters, was, like the other branches of human knowledge, obtained by accident. Their having accidentally produced beneficial effects on the health of people who made ufe of them, was, no doubt, the firft caufe which occafioned them to be diftinguifhed from common waters. The philofophers who turned their attention upon them, confidered only their fenfible qualities,— colour, gravity or lightnefs, tafte and fmell. Pliny took notice of a great many different forts of water, diftinguifhed either by confpicuous phyfical properties, or by the ufeful effects which they were capable of producing. But

* It is to be obferved, that though waters contain no mineral principles which can be difcovered by analyfis, they may yet produce fenfible effects on the animal œconomy. For this purpofe, they need only to be very light and active, and of an hotter temperature than common water. Such are the waters of Plombieres and Luxeuil, which differ only in temperature from common water.

But it was only in the feventeenth century that people began to think of examining the principles diffolved in thefe waters, by fubjecting them to chemical proceffes. Among the firft who attended to this object, was Boyle, who, in the account of his ingenious experiments on colours, publifhed at Oxford in the year 1663, mentions various re-agents, which, when poured into water, fhew, by the alterations which their colours fuffer, what fubftances are diffolved in the water.——The Academy of Sciences, ever fince their inftitution, have been highly fenfible of the importance of the analyfis of waters ; and in the year 1667, Duclos engaged in an examination of the different mineral waters in France. Among the earlier Memoirs of that Society, are the experiments of this chemift on thofe waters. Towards the end of the feventeenth century, Boyle engaged, in a more particular manner, in examining mineral waters ; and in the year 1685, he publifhed a work on the fubject. Boulduc, in the year 1729, publifhed an account of a procefs for analyfing mineral waters, greatly preferable to any of thofe which were commonly in ufe before that period : He directed to evaporate the water under examination ; and, during the progrefs of the evaporation, to feparate, by a filter, the fubftances depofited.

Various celebrated chemifts have fince been fuccefsful in refearches into the nature of mineral waters. None of them has failed to make important difcoveries concerning the different principles contained in thofe fluids. Thus Boulduc difcovered in them, natrum, the nature of which he afcertained,——Le Roy of Montpellier, calcareous muriate,——Margraf, magnefian muriate,——Dr Prieftley, carbonic acid,—— Meffrs Monnet and Bergman, fulphurated hydrogenous, or *hepatic*, gas. The two laft of thefe chemifts, befides enriching this department of chemical knowledge

knowledge with new difcoveries, have publifhed complete
treatifes on the procefles for the analyfis of mineral waters,
and have introduced into it, more accuracy and precifion,
by which it is greatly improved. There are, befides,
many analyfes of particular mineral waters, which have
been made by very ingenious chemifts, and throw much
light on this part of experimental knowledge, which is,
with good reafon, confidered as the moft difficult branch
of chemiftry. Our limits do not here permit us to enter
into a detail of all the information concerning mineral
waters to be found in the different works on the fubject:
But we fhall take care to mention, occafionally, the au-
thors from whom we derive the information which we
communicate.

§ II. *Of the Principles contained in Mineral Waters.*

IT is only within thefe few years, that all the principles
liable to be diffolved in mineral waters have been cer-
tainly known. The reafon of this may be naturally un-
derftood to be, that we have only of late acquired the
chemical knowledge neceffary to enable us to determine
the nature of thofe matters, and that their exiftence
could not be afcertained till the means proper for that
purpofe were adopted. Another reafon which has re-
tarded the progrefs of fcience in this department, is,
that mineral matters are never found diffolved in waters
but in very fmall quantities, and a number of them al-
ways mixed together; and thefe circumftances conceal
from obfervation the properties by which they are re-
fpectively diftinguifhed. Notwithftanding thefe and other
unfavourable circumftances, the numerous refearches of
the chemifts above mentioned, and of others to be here-
after

after taken notice of, have shewn, that several mineral substances are very generally found in water; that some others are but seldom found naturally dissolved in that fluid; and, lastly, that various mineral substances are never dissolved in it at all. Let us, however, review the different classes of these substances, in the same order in which we have already traced their history.

Siliceous earth is sometimes suspended in waters; and being then very much attenuated, it is not liable to be precipitated; but the proportion in which it is found is always exceedingly small.

Aluminous earth is likewise met with in waters. The extraordinary fineness of that earth, which causes it to be diffused all through water, makes it also destroy the transparency of the fluid. Argillaceous waters are therefore foul and whitish, and of a pearl or opaline colour : they likewise feel greasy, and have received the name of *saponaceous.*

Barytes, magnesia, and lime, are never pure in water, but always combined with acids.

Neither are the fixed alkalis ever found in water, in a state of purity, but often in neutral salts.

The same is the case with ammoniac and most of the acids. Yet carbonic acid is often found in waters, in a state of freedom, and possessed of all its properties : It even characterizes a particular class of mineral waters, known by the name of *gazeous, spiritous, or acidulated waters.*

There are none of the perfect neutral salts often found in solution in mineral waters, except sulphate of soda or *Glauber-salt*, muriate of soda, muriate of potash, and carbonate of soda.

Sulphate of lime, calcareous muriate, chalk, sulphate of magnesia or *Epsom-salt*, muriate of magnesia, and carbonate

bonate of magnefia, are more commonly met with in water than any of the other terrene. falts. As to nitrate of lime and nitrate of magnefia, which fome chemifts tell us they have found in mineral waters; thefe falts are fcarce ever found but in falt waters, not in mineral waters properly fo called.

Aluminous neutral falts, as well as thofe which have a bafe of barytes, are almoft never found in folution in waters. Alum or aluminous fulphate appears to exift in fome waters. †

Pure hydrogenous gas has not been hitherto found in mineral waters.

Neither has pure fulphur been found in thefe fluids: fometimes, though *but* feldom, they contain a fmall quantity of it in the ftate of fulphure of foda. But it is moft frequently fulphurated hydrogenous gas which mineralizes fulphureous mineral waters.

Laftly, Iron is more commonly found in mineral waters than any other of the metals: It is found in them in two different ftates,—either combined with carbonic acid, or in union with fulphuric acid. Some chemifts have been of opinion, that it may alfo exift in waters in a pure metallic ftate, without any intermediate acid. But as this metal is fcarce ever found in nature, unlefs in the ftate of oxide, and in combination with carbonic or fulphuric acid,— this opinion could never have been adopted, if its authors had not been ignorant of the exiftence of the former of thefe two acids, and at a lofs to conceive how iron could be diffolved in water, without the help of the

<div align="right">fulphuric</div>

† We fpeak not, here, of the opinion of Givre, and other chemifts, who thought alum to be one of the principles the moft prevalent in mineral waters; but of the accurate analyfes by which M. Mitouart difcovered the exiftence of alum in the waters of Dominique de Vals,—and M. Opoix, in the waters of Provins.

fulphuric acid.   Bergman afferts, that both it and man-
ganefe are found in fome waters in union with muriatic
acid.

Arfenic, fulphate of copper, and fulphate of zinc,
which are found in many waters, communicate to them
noxious qualities ; and the only reafon for being at pains
to detect any of thefe falts in water, is, in order that the
water may be carefully abftained from.

Several authors have admitted the exiftence of bitumen
in mineral waters ; but fcarce any chemift now agrees to
this.   It was the bitter tafte of thefe waters which made
them be fufpected to contain this oleaginous body.   But
bitumen is now known not to have any fuch tafte ; and
the waters are known to derive it from calcareous mu-
riate.

It is eafy to imagine, that as water runs through the
interior parts of the globe, efpecially in mountains, it
muft naturally be impregnated with the different fub-
ftances here enumerated.   The different ftrata of earth
through which waters run, and the extent of thofe ftrata,
likewife ferve to account for their being more or lefs im-
pregnated with mineral principles, and for the diverfity
of the principles found at different times in the fame wa-
ters,—— efpecially if to thefe confiderations we add, that
the various alterations to which our globe is liable, par-
ticularly at the furface, and in its more elevated parts,
muft often caufe thofe fluids to change the direction of
their courfe.

§ III.   *Different Claffes of Mineral Waters.*

FROM what has been here faid concerning the differ-
ent matters ufually contained in mineral waters, the
Reader may perceive, that the claffes of mineral waters
may

may be equal in number to the terrene, ſaline, and me-
tallic matters liable to be diſſolved in the fluid ; and of
conſequence very numerous. But it is to be obſerved,
that no one of the ſubſtances which we have enumerated
is ever found in waters alone, and unaccompanied with
any of the others ; and that waters often contain mine-
rals, to the number of three, four, five, or even more.
This is one difficulty unfavourable to a ſyſtematic diviſion
of mineral waters, according to the principles which they
contain. Yet, by conſidering principally the matter which
exiſts in the greateſt abundance in any mineral water,
and whoſe properties are the moſt eminent, we may form
diſtinctions which, though not exceedingly accurate, will
yet ſerve to indicate the nature of any of theſe fluids,
and enable us to judge of its virtues. In this way have
mineral waters been diſtinguiſhed by the different che-
miſts who have engaged in experiments upon them.
M. Monnet divides them into three claſſes,— alkaline,
ſulphureous, and ferruginous. From late diſcoveries,
it appears neceſſary to enlarge the number of the claſſes.
M. Duchanoy, who has publiſhed a valuable work upon
mineral waters, diſtinguiſhes them into ten claſſes,—
gazeous, alkaline, earthy, ferruginous, hot without any
mineral, gazeous bath-waters, ſaponaceous, ſulphureous,
bituminous, and ſaline waters. That author may indeed
be blamed for having extended the claſſes of mineral wa-
ters to too great a number, as we are unacquainted with
either pure gazeous, or pure bituminous waters ; yet his
diviſion is undeniably the moſt complete, and conveys the
moſt juſt ideas of the nature of the various mineral wa-
ters; nor could he have adopted any other more ſuitable
to his ſubject.

To explain briefly the order in which mineral waters
may be arranged according to their principles, and com-
plete

plete what we have already faid on this fubject, we fhall here propofe another divifion of thofe waters, lefs extenfive, but more regularly fyftematic than M. Duchanoy's: in which it is to be obferved, that we do not include bath-waters which are merely hot without an addition of any mineral, as the beft chemifts confider thefe as nothing elfe but hot water: neither do we choofe to include bituminous waters, as there are none, really fuch, known to exift in nature.

To us it appears, that all waters may be arranged in four claffes,—acidulated waters, falt waters, fulphureous waters, and ferruginous waters.

Class I. *Acidulated Waters.*

GAZEOUS Waters, which may be, with much more propriety, called *acidulated*, are waters in which carbonic acid predominates. They are known by the poignancy of their tafte, and the facility with which they boil, and give out bubbles, even by fhaking. They redden tincture of turnfole, and precipitate lime-water and alkaline fulphures. We know of no waters containing this acid, in a pure, infulated ftate; and waters of this clafs may therefore be fubdivided into feveral orders, according to the other principles contained in them, or the feveral modifications which they difplay. They all appear to contain either more or lefs of alkali and calcareous earth; but their different degrees of temperature enable us to divide them very naturally into two orders. The firft of thefe orders may comprehend cold acidulated and alkaline waters, fuch as thofe of Seltz, Saint Myon, Bard, Langeac, Chateldon, Vals, &c. Under the fecond, we may arrange hot or bath acidulated and alkaline waters,— fuch as thofe of Mont d'Or, Vichy, Chatelguyon, &c.

CLASS

Class II. *Saline or Salt Waters.*

WE give the name of *saline* or *salt waters* to waters holding in solution a quantity of neutral salts, sufficiently considerable to act in a very discernible manner, most commonly purgative, on the animal œconomy. It is easy to discover the theory and the nature of these waters : they are precisely like the solutions of salts which we prepare in the laboratory ; only, they almost always contain two or three different sorts of salts. Sulphate of soda is very seldom found in them : the saline principles by which they are generally mineralized are, sulphate of magnesia or Epsom salt, marine salt or muriate of soda, calcareous muriate, and magnesian muriate, either separately or together. The waters of Sedlitz, Seydschutz, and Egra, contain Epsom salt, which is usually mixed with muriate of magnesia. The waters of Balaruc contain muriate of soda, chalk, and calcareous and magnesian muriate : those of Bourbonne, contain muriate of soda, sulphate of lime, and chalk : those of La Mothe are still more compound than any of the preceding, and hold in solution, muriate of soda, sulphate of lime, chalk, sulphate of magnesia, muriate of magnesia, and an extractive matter. On this head, it is to be observed, that salts with a base of magnesia, are much more common in water than was thought till very lately ; and that, in analyses, they are seldom accurately recognized or distinguished from calcareous muriate.

Class III. *Sulphureous Waters.*

THE name of *sulphureous waters* has been given to mineral waters appearing to possess some of the proper-

ties of fulphur,—fuch as its fmell, and its power of co-
louring filver.   Chemifts were long ftrangers to the true
mineralizer of thefe waters.   Moft of them took it to be
fulphur ; but they could never prove the prefence of
fulphur,—at leaft, they could never detect more than a
few particles of it.   Thofe who examined fome of thefe
waters, admitted in them the exiftence either of fulphu-
reous fpirit, or of an alkaline fulphure.   Meffrs Venel
and Monnet were the firft who objected to this opinion ;
M. Monnet, efpecially, came very near the truth, by re-
prefenting fulphureous waters as fimply impregnated with
the vapour of *liver of fulphur.*   The younger Rouelle
fays likewife, that factitious fulphureous water may be
produced, by fhaking common water, in contact with air
difengaged by an acid from an alkaline fulphure.   Berg-
man has greatly improved this doctrine, by examining the
properties of fulphurated hydrogenous gas, of which we
fpoke under the article *fulphur.*   He has proved it to be
this gas which mineralizes fulphureous waters, which he
has therefore called, after it, *hepatic* waters ; and he gives
directions how to diftinguifh the prefence of fulphur.—
Notwithftanding thefe difcoveries, M. Duchanoy fpeak-
ing of fulphureous waters, allows them to contain ful-
phure, fometimes alkaline, fometimes calcareous, and
fometimes aluminous ; and in this he follows the opinion
of le Roy of Montpellier, who, as we related under the
hiftory of *fulphur,* propofed to form factitious fulphure-
ous waters from fulphure with a bafe of magnefia.   It
appears, that there are actually waters which contain a
little fulphure, and others again mineralized fimply by hy-
drogenous gas.   In this cafe, fulphureous waters muft
be diftinguifhed into two orders :—fulphureous waters,
containing naturally a little alkaline or calcareous ful-
phure ; and fulphureous waters, which are only impreg-
nated

nated with hydrogenous gas. The waters of Bareges and Cauterets, and the Bonnes waters, appear to belong to the former of thefe claffes; while, again, thofe of Saint-Amant, Aix-la-Chapelle, and Montmorency, belong to the fecond. Moft of thefe are hot-bath waters : The water of Enghien-les-Paris, or Montmorency, is cold.

CLASS IV. *Ferruginous Waters.*

AS iron is the moft plentiful, and the moft liable to alteration of all metals; it is by no means furprifing that water fhould be eafily impregnated with it. Accordingly, ferruginous waters are the moft copious, and the moft common mineral waters. Modern chemiftry has thrown much light on this clafs of waters. They were formerly thought to be all fulphuric. M. Monnet affirms, that fcarce any of them contain fulphate of iron ; and he is of opinion, that the metal is diffolved in them without the intervention of any acid.

It is now known, that iron, not in the ftate of fulphate of iron, is diffolved by means of carbonic acid ; and thus forms the falt which we have denominated *carbonate of iron.* Meffrs Lane, Rouelle, Bergman, and various other chemifts, have eftablifhed this truth beyond a doubt.—— The different proportions of carbonic acid, and the ftate of iron in waters which owe their virtues to this metal, induce us to diftinguifh this fourth clafs into three orders.

The *firft* comprehends acidulated martial waters, in which the iron is held in folution by carbonic acid, and the acid exifts in fo large a proportion, as to render them poignant, and fomewhat four to the tafte. The waters of Buffang, Spa, Pyrmont, Pougues, and La Dominique de Vals are of this order.

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The *fecond* order contains fimple martial waters, having the iron diffolved by carbonic acid, without any excefs of the acid. Thofe of Forges, Aumale, Condé, and moft other ferruginous waters belong to this order.—This diftinction among ferruginous waters was made by M. Duchanoy.

But we may add a *third* order, after M. Monnet.—This order comprehends waters containing fulphate of iron. Such waters are extremely rare ; but there are fome fuch. M. Monnet ranks the waters of Paffy in this order. M. Opoix admits the exiftence of fulphate of iron, even in a very confiderable proportion, in the waters of Provins. M. Fourcy, indeed, denies its exiftence in them, and imagines the iron in thofe waters to be diffolved by carbonic acid : But we cannot yet decide in this cafe ; for the refults of the two chemifts are directly oppofite to each other, and a new examination of the waters is therefore requifite. We may add, that iron is never found alone in waters : it is always mixed with chalk, fulphate of lime, different muriatic falts, &c. But as the metal is the principal bafis of the properties of fuch waters, they are, therefore, according to the principles which we have laid down, to be called *ferruginous waters* *.

As to faponaceous waters, which are admitted by M. Duchanoy, before we can allow their exiftence, we muft wait till chemical and medical experiments determine the caufe of their faponaceous properties, which that phyfician

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* In this claffical enumeration of waters, we avoid fpeaking of fuch as contain arfenic and copper ; they being confidered as poifonous. We likewife pafs over in filence waters containing ammoniacal falts and extractive fubftances, produced by the putrefaction of organic matters, over which the water has been ftagnated. Waters of thefe kinds are not medicinal.

ßcian thinks owing to clay, and the effects which thofe properties enable them to produce on the animal œconomy, as medicines.

From thefe particulars it appears, that all mineral or medicinal waters are comprehended in nine orders.

> Cold acidulated waters.
> Hot or bath acidulated waters.
> Sulphuric falt waters.
> Muriatic falt waters.
> Simple fulphureous waters.
> Sulphurated gazeous waters.
> Simple ferruginous waters.
> Ferruginous and acidulated waters.
> Sulphuric ferruginous waters.

§ IV. *Examination of Mineral Waters, as diftinguifhed by Phyfical Properties.*

AFTER mentioning what different matters are found in waters, and exhibiting a flight fketch of the manner in which they may be divided into claffes and orders, according to their principles ; we muft next give an account of the proceffes for analyfing them, and diftinguifhing, with all poffible accuracy, what fubftances they contain. This analyfis has been thought the moft difficult part of chemiftry ; and with good reafon ; as it requires both a familiar knowledge of all chemical phænomena, and fkill in conducting chemical operations. In order to afcertain, with accuracy, the nature of water, we muft, 1. obferve the fituation of the fpring from which it proceeds, and defcribe faithfully the neighbouring grounds, and ftrata of minerals ; and, in order to difcover the nature of thofe ftrata, it will be neceffary

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to dig trenches, and examine, by a narrow inſpection, with what ſubſtances the water is liable to be impregnated.   2. The phyſical properties of the water, its taſte, ſmell, colour, tranſparency, weight, and temperature, are next to be examined.   Two thermometers, graduated ſo as to riſe and fall as nearly together as poſſible, with an arœometer, are requiſite for this purpoſe. Theſe preliminary experiments ſhould alſo be made in different ſeaſons, at different hours of the day, and when the atmoſphere is in different ſtates.   Long continued dryneſs, or copious rains, have a powerful influence on waters.   Theſe firſt obſervations generally ſhew to what particular claſs the water under examination is to be referred, and, of conſequence, regulate the remaining part of the analyſis.   3. Sediments in the bottom of baſons containing water, ſubſtances ſwimming on its ſurface, and ſublimated matters exhaled from it, are too important objects of obſervation to be neglected.   After this preliminary examination, we may proceed to analyſis properly ſo called, which is performed in three ways, —by reagents, by diſtillation, and by evaporation.

§ V. *Examination of Mineral Waters by Reagents.*

THE name of *reagents* is given to ſubſtances which are mixed with waters, in order to diſcover, by the phænomena which they produce, the nature of the matters which thoſe waters hold in ſolution.

The moſt exact chemiſts · have always conſidered the uſe of reagents as a very uncertain means of diſcovering the principles of mineral waters.   Their reaſons for thinking ſo, are, that the action of reagents never indicates, in an exact manner, the nature of the matters held in ſolution by thoſe waters ; and the cauſes of the chan-

ges

ges produced in mineral waters by the mixture of re-
agents, are frequently unknown : in truth, the faline
matters employed for this purpofe, are capable of pro-
ducing many changes, concerning the nature of which it
is very hard to fay any thing decifive. Moft of thofe,
therefore, who have engaged in refearches of this nature,
have put but little truft in reagents : They have
thought evaporation a much furer way of difcovering
the nature and the quantity of the principles of mineral
waters. And in the beft works on the analyfis of thefe
fluids it is laid down as a principle, that reagents are to
be ufed only as auxiliaries, which, at the utmoft, only
afford grounds for plaufible conjectures concerning the
principles by which the waters are mineralized. On
this account, only a certain number of reagents are now
admitted ; and the lift of thofe employed by the earlier
chemifts is greatly reduced.

But it cannot at prefent be doubted, that, how-
ever gentle the heat neceffary for the evaporation
of waters, yet it muft produce fenfible alterations on their
principles, and change their nature fo far. as to make
their refidue, when examined by chemical proceffes, afford
compounds different from thofe which were diffolved in
the water. The lofs of the gazeous matters, which are
often among the moft active principles of mineral wa-
ters, occafions a fingular change of their nature ; and,
befides caufing feveral bodies to be precipitated which
owe their folubility to the prefence of thofe volatile fub-
ftances, produces a reaction among the other fixed mat-
ters which alters their properties. The phænomena of
the double decompofitions effected by heat, on com-
pounds which fuffer no alteration in cold water, cannot
be properly eftimated, without a long feries of experi-
ments ; and our ideas concerning them, are therefore

as yet but very imperfect. Without entering into a tedious detail of particulars, it is enough, that the truth of this fact is allowed by all chemists, to convince us that it cannot be referred solely to evaporation. But is there any means of determining the nature of the substances diffolved in waters, without having recourfe to the action of heat? Does the more accurate knowledge of chemical phænomena, which we have derived from the numerous experiments of modern chemifts, afford any procefs by which the errors into which we are liable to be led by the refults of evaporation, may be corrected? The particulars which I am about to mention, which are extracted from a Memoir read by me before the Royal Society of Medicine, will fhew that very pure reagents, employed in a certain way, may be rendered much more ferviceable in the analyfis of mineral waters than has been hitherto thought.

Among the numerous reagents, the ufe of which has been propofed in the analyfis of mineral waters, thofe from which moft advantage may be derived, are, tincture of turnfole, fyrup of violets, lime-water, pure or cauftic potafh, cauftic ammoniac, concentrated fulphuric acid, nitrous acid, prufliate of lime, gallic alcohol, or *fpiritous tincture of nut-galls ;* nitric folutions of mercury and filver ; paper coloured by the aqueous tincture of fer—mbouc, which is rendered blue by alkalis ; the aqueous tincture of *terra merita,* to which the fame falts communicate a red-brown colour ; oxalic acid, for detecting the prefence of even the fmalleft poffible quantity of lime ; and barytic muriate, for afcertaining the prefence of even the moft trifling quantities of fulphuric acid.

The effects and the ufe of thefe principal reagents have been explained by all chemifts ; but the particular ftate in which they are to be ufed has not been fufficiently

ciently attended to. Before employing them, we fhould carefully make ourfelves acquainted with their nature, that we may not incur miftakes refpecting their effects. Bergman has enlarged, at great length, on the effects which they are capable of producing. That celebrated chemift tells us, that paper coloured by tincture of turn-fole, takes ftill a deeper colour when expofed to the action of alkalis, but fuffers no alteration of colour from carbonic acid. As it is principally with a view to afcertain the prefence of this acid, that this colouring matter is ufed, he advifes to employ its tincture only in water, and to dilute it to fuch a degree as to make it take a blue colour. He abfolutely rejects the ufe of fyrup of violets, becaufe it is liable to ferment, and is fcarce ever to be obtained genuine in Sweden. M. de Morveau adds, in a note, that it is eafy to diftinguifh fyrup coloured by turnfole, by means of corrofive fublimate, which communicates to it a red colour, but gives to fyrup of violets a green colour.

Lime-water is one of the moft ufeful reagents in the analyfis of mineral waters, although few chemifts have made exprefs mention of it in their works. This fluid decompofes metallic falts, efpecially fulphate of iron, the metallic oxide of which it precipitates. It feparates a-luminous earth or magnefia, from the fulphuric, or the muriatic acids, with which thofe fubftances are often combined in waters. It alfo indicates, by precipitation, the prefence of carbonic acid. M. Gioanetti, a phyfi-cian of Turin, has ingenioufly contrived to afcertain, by lime-water, the proportion of carbonic acid contained in the waters of St Vincent. That chemift, after obferv-ing that the bulk of this acid, from which people have been in ufe to judge of its quality, varies with the tem-perature of the atmofphere, mixed nine parts of lime-

water

water with two of the water of St Vincent's. He weighed carefully the calcareous earth formed by the tranfition of the carbonic acid from the mineral water into the lime; and found, by Jacquin's fcale, which fhews thirteen ounces of this acid to be contained in thirty two ounces of chalk,—that the water of St Vincent's contains fomewhat more than fifteen grains. But as lime-water is capable of detaching carbonic from fixed alkali, as well as of feizing that which is in a difengaged ftate; M. Gioanetti, in order to afcertain exactly the quantity of the latter, performed the fame operation with water deprived of its difengaged acid by ebullition. This procefs may therefore be employed to determine, in an eafy and accurate manner, the weight of the difengaged carbonic acid contained in any gazeous mineral water.

One of the chief reafons which have induced chemifts to pay little regard to the phænomena produced by reagents in the analyfis of mineral waters, is, that they fhew the exiftence of various fubftances in thofe waters; and it is then very difficult to difcern exactly what effect they produce. This obfervation chiefly regards potafh confidered as a reagent; for this alkali decompofes all falts formed by the union of acids with aluminous earth, magnefia, lime, and metallic matters. When alkali precipitates a mineral water, it cannot be determined, merely by infpecting the precipitate, what is the particular nature of the earthy falt decompofed in the experiment. Its effects are ftill more uncertain, when potafh faturated with carbonic acid is employed, as is commonly done; for the acid combined with the alkali, then increafes the confufion. For this reafon, I recommend the ufe of very pure cauftic potafh; which has, befides, another advantage over effervefcent alkali, as it

indicates

indicates the prefence of chalk, which may be diffolved in gazeous water by means of an excefs of carbonic acid. As it feizes the acid, the chalk becomes infoluble in the water, and is precipitated. I made myfelf certain of this fact, by pouring foap-makers' lixivium, recently prepared, into factitious gazeous water holding chalk in folution. The chalk was by degrees precipitated, as the cauftic fixed alkali feized the carbonic acid by which it had been held in folution. On evaporating this water to drynefs, after filtration, I obtained carbonate of foda, which effervefced in a very difcernible manner with acids. Cauftic fixed alkali will alfo produce a precipitate in mineral waters, even when they contain no earthy falts. If they contain only an alkaline neutral falt, lefs foluble in its nature than the cauftic alkali, the latter will then precipitate it as it unites with the water, nearly in the fame way as alcohol does. M. Gioanetti obferved this phænomenon in the waters of St Vincent : it is, befides, eafy to exhibit it, by pouring cauftic alkali into a folution of fulphate of potafh or muriate of foda : either of thefe falts is foon precipitated.

Cauftic ammoniac is, in general, lefs liable to occafion miftakes, when mixed with mineral waters ; for it decompofes only falts having a bafe of aluminous earth or magnefia, but does not precipitate calcareous falts. But there are two important obfervations to be made on this head. The firft is, that the ammoniac muft be very cauftic, not containing a fingle particle of carbonic acid ; if not in this pure ftate, it decompofes falts with a bafe of lime, by double affinity. The fecond is, that this mixture muft not be left expofed to the air, when we defire to know in what manner it acts fome hours after its formation ; for, as has been very properly obferved by M. Gioanetti, this falt, in a fhort time, attracts carbonic acid from the atmofphere,

and

and thus becomes capable of decompofing calcareous
falts. To remove every doubt concerning fo important
a matter, I made three decifive experiments.—After dif-
folving in diftilled water, a few grains of fulphate of
lime, prepared from tranfparent calcareous fpar, with
very pure fulphuric acid, (a precaution indifpenfibly re-
quifite,—as Spanifh white, or chalk, contains both mag-
nefia and river water), I feparated the folution into two
parts. Into the firft, I poured a few drops of ammo-
niac very recently prepared and very cauftic. I put
this mixture into a clofe-ftopped phial. After eight-and-
forty hours, it was clear and tranfparent, without any
fediment : No decompofition had, therefore, taken place.
The fecond portion was treated in the fame way, with
ammoniac, but put into a veffel admitting air. At the
end of a few hours, there was formed on the upper part
of it, a cloud, which became, by degrees, thicker, and
was at laft precipitated. The precipitate afforded a live-
ly effervefcence with fulphuric acid, and thereby formed
fulphate of lime. The carbonic acid contained in this
precipitate muft have been fupplied by the ammoniac,
by which it had been attracted from the atmofphere.
This combination of carbonic acid and ammoniac forms
ammoniacal carbonate, capable of decompofing calcareous
falts by a double affinity,—as has been fhewn by Dr
Black, M. Jacquin, and feveral other chemifts,—and as
any perfon may fee, on pouring a folution of ammonia-
cal carbonate into a folution of fulphate of lime, which
cauftic ammoniac does not render turbid. Laftly, to
make myfelf ftill more certain of the phænomena of
this fecond experiment, I took the firft portion of the
water united with the ammoniac ; which, having been pre-
ferved in a clofe veffel, had loft nothing of its tranfpa-
rency. I turned the mouth of the phial containing it
upon

upon a funnel belonging to a very small pneumato-che-
mical apparatus, and passed into this mixture, by means
of a syphon, the carbonic acid gas disengaged from the
effervescent fixed alkali by the sulphuric acid. As this
acid passed in bubbles through the mixture, it became
turbid, in the same way as lime-water on the same occasion.
On filtrating it, chalk was found on the filter; and the fil-
trated ammoniacal sulphate, by evaporation. The gazeous
water, or liquid carbonic acid, produced the same de-
composition in another mixture of sulphate of lime and
caustic ammoniac. This decisive experiment fully proves,
that it is only by double affinity, and by the addition of
carbonic acid, that ammoniac decomposes sulphate of
lime. From this it appears, that when we need to
preserve a mixture of mineral water with ammoniac,
for a few hours, (which is at times necessary, as there are
some earthy salts which it decomposes but very slowly),
this experiment must be performed in a perfectly close
vessel, left access of air occasion a deceitful result. This
precaution is, in general, highly necessary in the use of
all reagents: Bergman and M. Gioanetti have also given
directions for performing it. I shall here add an obser-
vation concerning the use of ammoniac. As it is not
easy to obtain ammoniac absolutely caustic, and as it is
indispensibly necessary to have it such in analysing mine-
ral waters; a simple process may be used, of which I
have often found the advantage. Pour a little ammoni-
ac into a retort, having its extremity immersed in the
mineral water: heat the retort gently; the ammoniac
gas will then be disengaged, and will pass, in an highly
caustic state, into the water. If it produce a precipitate,
the mineral water must certainly contain either alumi-
nous or magnesian salts, or sulphate of iron: the colour
of the precipitate will show the particular nature of the
salt.

falt. This precipitate moft frequently confifts of the chalk which was diffolved in the water, by means of carbonic acid. The ammoniac abforbs that acid, and the chalk is then depofited. It is hard to fay, from the properties of the earthy precipitate, formed in mineral water by cauftic ammoniac, to which of the two bafes it is to be referred, and whether the neutral falt decompofed be magnefian or aluminous. But the manner in which it is formed, will indicate its character. On diffolving fix grains of fulphate of magnefia in four ounces of diftilled water, and fix grains of alum in the fame quantity of this fluid, and caufing a little ammoniac gas to pafs into each of thefe folutions; the former became inftantaneoufly turbid; but twenty minutes elapfed before the alum began to be precipitated. Care had been taken to have the phial which contained this mixture very clofely ftopped. The fame phænomena took place with nitrate and muriate of magnefia, and aluminous earth, diffolved in an equal quantity of diftilled water, and treated with the fame precautions. The rapidity or flownefs with which a mineral water is precipitated by the addition of ammoniac gas, is therefore a criterion by which we may diftinguifh the nature of the terrene falt which that alkali decompofes. In general, falts with a bafe of magnefia are much more common in water, than falts with a bafe of aluminous earth. I muft not forget to mention a fact related by Bergman : Ammoniac will form, with fulphate of magnefia, a compound in which a portion of that neutral falt, not decompofed, is combined with a portion of ammoniacal fulphate. Perhaps this undecompofed portion of the fulphate of magnefia forms, with the ammoniacal fulphate, a mixed neutral falt, refembling ammoniaco-mercurial muriate, or *alembroth falt.* Ammoniac,

niac, therefore, precipitates only a part of magnefia, and cannot indicate the exact quantity of *Epfom-falt* to which it ferves for a bafe. I would therefore prefer lime-water for afcertaining the nature and the quantity of falts with a bafe of magnefia contained in mineral waters. It poffeffes likewife the property of precipitating falts with a bafe of aluminous earth, much more fpeedily, and in much greater abundance than ammoniac gas *.

Concentrated fulphuric acid produces a dull white precipitate in water, containing barytes : but as this earth is but very feldom found in mineral waters, I pafs to the other effects of this reagent. When it produces bubbles in any mineral water, it indicates the prefence either of chalk, carbonate of foda, or pure carbonic acid. The prefence of each of thefe fubftances, is diftinguifhed by fome peculiar phænomena. When we heat water, containing chalk, after pouring into it fulphuric acid, there are fpeedily formed a pellicle, and a fediment of fulphate of lime ; which does not happen on the fame occafion to waters fimply alkaline. It would, at firft, appear, that fulphate of lime muft be precipitated affoon as fulphuric acid is poured into water containing chalk : but this very feldom happens without the help of heat ; as thefe waters generally contain an excefs of carbonic acid, which promotes the folution of fulphate of lime ;

and

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* The Reader will perceive, that I am repeating feveral facts which have been previoufly mentioned in the courfe of the work. I have made no fcruple of doing fo, in order to render this little treatife on the analyfis of mineral waters the more intelligible and compleat ; and in order to exhibit together, all thofe principles and facts concerning the proceffes for analyfing them, which it appears fo abfolutely neceffary for him to poffefs who engages in experiments of this nature.

and they muſt be deprived of that acid before the ſalt can be ſeparated. Convincing evidence of this fact may be obtained by pouring a few drops of concentrated ſulphuric acid into a certain quantity of lime-water, precipitated and afterwards clarified by carbonic acid. If the lime-water contain a good deal of regenerated calcareous earth, a precipitate of ſulphate of lime will be formed, either in a few minutes, or more ſlowly, and in proportion as the free carbonic acid is ſeparated. If a precipitate be not formed ſimply by reſt, which happens when the water contains but little ſulphate of lime, and a conſiderable exceſs of carbonic acid, expoſure to a gentle heat will produce in the liquor a pellicle and a precipitate of calcareous ſulphate.

The red nitrous acid is recommended by Bergman for precipitating ſulphur from *hepatized* waters. To prove the certainty of the fact, all that is neceſſary, is, to pour a few drops of this ruddy fuming acid into diſtilled water, into which gas diſengaged by acids from cauſtic alkaline ſulphure has been previouſly introduced, through a pneumato-chemical apparatus. This artificial *hepatized* water, which differs from natural ſulphureous waters in being more highly charged with mineralizing matter, and conſequently liable to be more eaſily decompoſed, affords a precipitate with nitrous acid, in the ſpace of a few moments. This precipitate is of a yellowiſh white colour: when collected on a filter and dried, it burns with the flame and ſmell peculiar to ſulphur, of which it poſſeſſes all the characteriſtic properties. It appears that nitrous acid alters ſulphurated hydrogenous gas, as well as all other inflammable matters, in conſequence of its containing ſuch a quantity of oxigene, in that particular ſtate in which it exiſts in it. Scheele has recommended the oxigenated muriatic acid for precipitating ſulphur from
theſe

thefe fame waters. Only a very little of it muft be ufed; for any extraordinary quantity burns the fulphur, and reduces it to fulphuric acid, as I have obferved of the water of Enghien. The fulphureous acid precipitates fulphur from mineral waters with great facility.

No reagent is more imperfectly known, in refpect to the manner in which it acts, than the alkaline lixivium of blood, called *phlogifticated alkali*. Chemifts have long ago obferved, that this liquor contains Pruffian blue ready formed. It was thought that this blue might be feparated from it by an acid; and it has been propofed, in this ftate, as a fubftance capable of detecting iron in mineral waters. Can the colouring part of Pruffian blue be contained in the lixivium of the blood, as was Bucquet's opinion, and as has been fince afferted by M. Baunach? However that may be, that lixivium ought not to be employed. Macquer, in confequence of his difcovery concerning the decompofition of Pruffian blue by alkalis, has propofed the ufe of potafh faturated with the colouring matter of this blue, for the purpofe of afcertaining the exiftence of iron in mineral waters. However, as this liquor ftill contains a little Pruffian blue that may be feparated by an acid as Macquer has directed, M. Baumé advifes to add to this Pruffian alkali, two or three ounces of diftilled vinegar to the pound, and to digeft it by a moderate heat till the whole of the Pruffian blue be precipitated. Pure fixed alkali muft then be poured in, to faturate the acid of vinegar. Notwithftanding the ingenuity of this procefs, I have had occafion to obferve, that this Pruffian alkali purified by vinegar, fometimes depofites blue, at the end of a long time,—efpecially if evaporated. M. Gioanetti made the fame obfervation, when he evaporated to drynefs a quantity of Pruffian alkali purified according to M. Baumé's directions. He has propofed two different procefses for rendering this liquor more

pure, and freeing it of every particle of iron. In the one, he directs to supersaturate Prussian alkali with distilled vinegar, evaporate it to dryness by a gentle heat, dissolve the mass remaining in the distilled water, and filtrate the solution. All the Prussian blue remains on the filter, and the liquor contains no more of it. The other process consists in neutralizing this alkali with a solution of alum, filtrating the liquor, and separating the sulphate of potash by evaporation. These two liquors afford not an atom of Prussian blue with pure acids, nor yet by evaporation to dryness. Lime-water, saturated with the colouring matter of Prussian blue, of which I have spoken under the article *iron*, does not require all these operations. When poured on a solution of sulphate of iron, it instantaneously forms a pure Prussian blue, without any mixture of green. Acids precipitate from it nothing but a few particles of blue. It therefore contains no iron ; and is preferable to Prussian alkalis for the purpose of assaying mineral waters. The cause of this phænomenon must doubtless be, that lime dissolved in water does not act near so powerfully on iron as alkalis. This prussiate of lime appears to me very proper for detecting iron in ferruginous waters, whether gazeous or sulphuric. In fact, as the carbonic gas which holds iron in solution in waters is of an acid nature, it decomposes Prussian lixivia by double affinity, just as well as sulphate of iron does. I tried prussiate of lime on the waters of Spa and Passy : I instantaneously obtained, in that of Spa, a discernible blue, and in that of Passy, a very copious blue. Here, therefore, is a liquor which may be very easily prepared, and contains no Prussian blue ; and is therefore very proper for the purpose of indicating the presence of even the smallest quantity of iron in waters. It is a sort of neutral salt, formed by the combination of the Prussic acid, or the

colouring

colouring part of Pruffian blue with lime. I have obferv-
ed, in the hiftory of iron, that M. Scheele has deduced the
fame inference concerning the utility of this liquor, from
an account of a trial of it which I publifhed in the year
1780.

Nut-gall, and all four, aftringent vegetable fubftances,
oak-bark, the fruit of the cyprefs-tree, the hufks of
nuts, &c., precipitate folutions of iron, and communicate
to that metal different colours, according to its quanti-
ty, its particular ftate, and the ftate of the water in
which it is diffolved. There are a vaft variety of fhades
of this colour, from a pale rofe-colour, to the deepeft black.
It is acknowledged, that water's deriving a purple colour
from a mixture of tincture of nut-gall, is no proof that
iron exifts in it in a metallic ftate ; for fulphate and car-
bonate of iron likewife take a purple colour by the infu-
fion of nut-gall. It is rather the quantity of the iron, the
degree of its adherence to the water, and the ftage to
which the decompofition of the folution is advanced, to
which the diverfities of colour, obfervable in thefe pre-
cipitations, are to be afcribed ; as has been very well ob-
ferved by M. Duchanoy, in his Effays on the Art of
forming Factitious Mineral Waters. We have formerly
mentioned, that the aftringent principle is in fome mea-
fure a peculiar acid, as it combines with alkalis, gives
a red tinge to blue vegetable colours, decompofes alka-
line fulphures, and combines with metallic oxides. To
afcertain the prefence of iron in a mineral water, pow-
der of nut-gall, a cold infufion of the fame fubftance,
and a tincture formed from it with alcohol are employed.
The tincture is preferred to the other two preparations;
being much lefs liable to alteration than the folution in
water, which foon becomes mouldy. What is more fin-
gular, the products of diftilled nut-gall likewife colour
ferruginous folutions. The folution of it in acids, in al-

kalis, in oils, or in æther, exhibits the fame phænome-
non. The ftate of the iron which this matter precipi-
tates from acids is very little known : it is a fort of neu-
tral falt, which, though very black, is not fubject to the
attraction of the magnet. It diffolves flowly, and
without any perceptible effervefcence, in acids. The
action of fire deprives it of thefe properties, and ren-
ders it fubject to attraction. Nut-gall is fo powerful a
reagent, that one drop of its tincture will, in the fpace
of five minutes, colour water containing fulphate of iron,
only in the proportion of one twenty-fourth part of a
grain to nearly three pints.

The two laft reagents which we fhall propofe to be
ufed in examining waters, are the folutions of filver and
mercury in the nitric acid. Thefe folutions have been
ufed to detect the fulphuric and the muriatic acid in mi-
neral waters. But feveral other fubftances will alfo pre-
cipitate them, which contain not a particle of either of
thofe acids. The white, ponderous ftriæ which the fo-
lution of filver produces in water containing muriate of
foda, only in the proportion of half a grain to the pint,
demonftrate, in a very fimple and unequivocal manner,
the prefence of the acid of that falt : But they do not,
in the fame manner, detect the fulphuric acid ; for, by
Bergman's calculation, at leaft thirty grains of fulphate
of foda to the pint, are neceffary to its producing a fenfi-
ble effect. Add to this, that fixed alkali, chalk, and magne-
fia, precipitate the nitric folution of filver in a much more
diftinct manner. The precipitation of a mineral water
by this folution cannot therefore ferve to determine,
in a precife manner, to what faline or earthy fubftance
its mineralization is owing.

The folution of mercury by the nitric acid, is ftill
more liable to occafion miftakes. It not only indicates
the prefence of the fulphuric and the muriatic acids in
waters,

waters, but is alfo precipitated, in a yellowifh powder, by al-
kaline and earthy carbonates; a property which might
occafion miftakes with refpect to the fulphuric acid. It is
commonly thought, that the very copious white precipitate
which it produces in water, muft be owing to the pre-
fence of a muriatic falt; but mucilages and extractive
fubftances difplay the fame phænomenon,—as is at pre-
fent well known to all chemifts. Befides thefe errors
and uncertainties to which we are liable in applying the
nitric folution of mercury to this purpofe, in confequence
of its producing the fame precipitate with various fubftan-
ces, the ftate of the folution itfelf is likely to occafion others;
of which we need to be aware, in order to avoid fome
blunders of no fmall confequence, which we may other-
wife commit in analyfing waters. Bergman has taken
notice of a part of the fingular diverfities obfervable in
this folution, in confequence of its being prepared hot
or cold,—efpecially with refpect to the colour of the pre-
cipitates which it affords by different intermedia: But he
has not faid a word concerning the property which this
folution poffeffes, of being liable to precipitation by
diftilled water, when highly faturated with the mercurial
oxide; although M. Monnet had announced this fact
in his Treatife on the Solution of Metals. As this is
a matter of great importance in regard to the analyfis of
waters, I therefore engaged in a more particular exami-
nation of it, with a view to afcertain and eftablifh, at
leaft fomething concerning it; and I fucceeded, as I am
about to relate, by a very fimple procefs. I made a great
many folutions of mercury in very pure nitric acid, with
different proportions of the two fubftances, hot and cold;
and ufing acids of various degrees of ftrength. The
following were the refults of my experiments.

B b 3

1. Solu-

1. Solutions prepared cold, are, with more or lefs rapidi-ty, charged with a quantity of mercury, which is greater or fmaller, according as the nitric acid is more or lefs con-centrated. But, whatever quantity of mercury a concen-trated acid may have diffolved cold, this folution is never precipitated by water. I diffolved, in cold, two drachms and a half of mercury, in two drachms of red, and high-ly fuming nitrous acid : the whole weighed, in a bottle containing an ounce of diftilled water, one ounce, four drachms, and five grains. The combination took place with amazing rapidity : More than one fourth of the acid was loft in very thick nitrous gas, and in aqueous va-pours exhaled by the heat of the mixture. This folu-tion was of a dark-green colour, and very tranfparent. I poured fome drops of it into half an ounce of diftilled water : there were immediately formed fome whitifh ftriæ, which were diffolved by fhaking, and did not yield a precipitate. This, however, was the moft con-centrated folution that I could prepare in a cold tempe-rature : it difplayed the moft confiderable motion and effer-vefcence, and yielded the largeft quantity of ruddy vapours. As it had depofited cryftals, I added two drachms of di-ftilled water, which diffolved the whole, without exhibiting any appearance of a precipitation. Such, therefore, as are prepared in a cold temperature, with common nitric acid, and half their weight of mercury, can be in no danger of being precipitated by water, and may be con-fidently employed in the analyfis of mineral waters.

2. However weak the nitric acid, when expofed over mercury to a confiderable heat, it diffolves more of the me-tal than the fame acid cold will diffolve, even in the ftrong-eft ftate. The folution is of a light-yellow colour, and fat and thick : by reft, it precipitates a yellowifh, fhapelefs mafs, which, with boiling water, may be changed into

yellow

yellow oxide, or beautiful *turbith*. This solution, when poured into diftilled water, forms a very copious precipitate, of a yellow colour refembling *turbith*. A folution prepared in a cold temperature, will exhibit the fame refult, if expofed to a heat fo intenfe as to make it exhale a good deal of nitrous gas. Thefe heated folutions fhould not be employed in the analyfis of mineral waters; for they are decompofed by diftilled water.

3. The only difference between thefe two forts of folutions appears to be, that there is a much larger quantity of mercurial oxide in that which is precipitated by water, than in that which is not decompofable in this fluid. I proved this truth by a comparative evaporation of equal quantities of the two folutions, in medical phials, in order to reduce them to red precipitate. I obtained, from the folution which is liable to precipitation by water, one-fourth more than from the other. The fpecific gravities likewife afford a criterion by which the refpective proportions of the oxide of mercury in thefe different liquors may be eftimated. I compared the weights of equal quantities of three different folutions of mercury. One of them, which yielded no precipitate in diftilled water, and had been formed by the firft of the above-mentioned operations, weighed one ounce, one drachm, and fixty-feven grains, in a bottle containing an ounce of diftilled water. The fecond, which had been prepared by a very gentle heat, communicated a light, opaline colour to diftilled water, without producing any very difcernible precipitate: it weighed, in the fame bottle, one ounce, fix drachms, and twenty-four grains. Laftly, the third of thefe mercurial folutions, which was pretty hot, and precipitated a true turbith mineral, of a dirty-yellow colour in diftilled water, weighed one ounce, feven drachms, and twenty-five grains. I had

ftill

ftill one decifive experiment to make, which might either confirm or refute my opinion. If the folution which af-forded a precipitate in diftilled water, owed that proper-ty to its containing an excefs of mercurial oxide ; in that cafe, the addition of more acid might be expected to render it incapable of yielding a precipitate ; and this actually happened. On pouring aquafortis into a folution which was decompofable by water, it was immediately rendered incapable of yielding a precipitate to that fluid, and reduced into the fame ftate with that which is pre-pared flowly, without the application of any greater heat than the temperature of the atmofphere. M. Mon-net has already recommended this procefs, to preferve cryftals of mercurial nitrate from being reduced to oxide by the contact of the air. By a contrary procefs, and by evaporating a portion of the acid of a good folution not fufceptible of precipitation by water, it may be re-duced to a folution containing a much larger proportion of mercurial oxide, and confequently fufceptible of de-compofition by water. It may be reftored to its former ftate, by adding a quantity of acid equal to what it has loft.

These confiderations appeared to me of importance, in order to render the effects of reagents on water, fome-what lefs uncertain. But, whatever the accuracy with which we proceed in thefe refearches, however exten-five our knowledge of the degrees of purity, and the different ftates of the fubftances which are combined with mineral waters, in order to difcover their princi-ples ; if it muft be acknowledged, that each of thofe reagents indicates the prefence of two or three different matters; we muft be always at a lofs to afcertain the particular nature of the refults which they at any time produce. Lime, for inftance, feizes carbonic acid : it

precipitates

precipitates both falts that have alumina or magnefia for their bafe, and metallic falts : Ammoniac produces the fame effect : fixed alkali precipitates both thefe and calcareous falts : calcareous prufliate, prufliate of potafh, and gallic alcohol, precipitate fulphate and carbonate of iron : the nitric folutions of filver and mercury decompofe all fulphuric and muriatic falts, however different, or however mingled together in the fame water ;—they are alfo decompofed themfelves, by alkalis, chalk, and magnefia. Amid thefe complicated phænomena, how is it poffible to difcern the peculiar nature of any alteration produced in water by any of thofe reagents, or to diftinguifh, from their operation, whether the water be fimple or compound ?

Thefe queftions, though very perplexing at a time when chemiftry was not confcious of all her ftrength, may now, however, be difcuffed, even with hopes of refolving them in a fatisfactory manner.—In the firft place, I obferve, that the nature of reagents is much better known than it was a few years ago, and their reaction on the principles of waters much more accurately determined ; and, from thefe circumftances, there is good reafon to think, that they may now be ufed with much more advantage than has been hitherto imagined. Yet, among the many fkilful chemifts who have employed their labours in the analyfis of waters, none but M. Baumé, Bergman, and Gioanetti, have had any idea of the advantages which may be derived from a more liberal ufe of thofe fubftances. Chemifts have long been in ufe to examine mineral waters by reagents in very fmall quantities, and commonly in glaffes : the phænomena of the precipitation produced in this cafe are carefully obferved, but the experiment is carried no farther. M. Baumé, in his Chemif-
try,

try, advifes to faturate a certain quantity of mineral water which you wifh to examine, with fixed alkali and acids, to collect the precipitates, and examine their nature. Berg-man thinks, that from the weight of the precipitates ob-tained from fuch mixtures, the quantity of the mineral-izing principles contained in the waters may be eftimat-ed. Other chemifts, too, have tried this method ; but al-ways with fome particular views: Nobody has ever thought of making a regular and compleat analyfis of mineral waters by this procefs. To· accomplifh it, in my opi-nion, feveral pounds of mineral water fhould be mixed with each reagent, till the reagent ceafe to produce a precipitate from the water. It may be left for the fpace of twenty-four hours in a clofe-ftopped veffel, to depofite the precipitate ;—then filtrate the mixture, and, after weighing and drying it on a ftove, examine the precipi-tate which remains on the filter by the ufual methods. Thus you may difcover, with certainty, the nature of the fubftance on which the reagent has acted, and deter-mine the caufe of the decompofition which it has pro-duced. Order may be obferved in thefe operations, by firft mixing the waters with thofe fubftances which are leaft capable of altering them, and proceeding to the ap-plication of fuch fubftances as may produce on them a greater variety of changes, and thofe moft difficult to e-ftimate. I ufually proceed in the following manner in this fort of analyfis. After examining the tafte, colour, weight, and all the other phyfical properties of a mine-ral water, I pour four pounds of lime-water on an equal quantity of the fluid which I am examining : if no preci-pitate is formed in the fpace of twenty four hours, I am fure that the water contains neither free carbonic acid, alkaline carbonate, neutral falts with a bafe of alumi-nous earth or magnefia, nor metallic falts. But when

a precipitate

a precipitate is either inftantaneoufly or gradually form-
ed, I filtrate the mixture, and examine the chemical pro-
perties of the fediment. When the fediment has no
tafte, is infoluble in water, effervefces with acids, and
forms with the fulphuric acid an infipid falt, almoft
infoluble in water; I conclude, that it is chalk, and
that the lime-water has taken up no principle but car-
bonic acid from the mineral water. Again, when the
precipitate is but fcanty, is not readily depofited, pro-
duces no effervefcence, and affords with fulphuric acid
a ftyptic, or bitter, and very foluble falt, it muft then
confift of magnefia or aluminous earth, or poffibly of
both. I need not here enlarge upon the means for dif-
tinguifhing between thefe two fubftances; they muft be
already well known. I fhall only add, that fuch a vari-
ety of thofe means may be ufed, as to leave no doubt
with refpect to the nature of the fubftance precipi-
tated.

After this procefs of examination with lime-water, I
pour on the fame mineral water one or two drachms of
very cauftic ammoniac, or introduce into it ammoniac
gas, difengaged from that liquid falt by heat. When
the water is faturated, I leave the mixture to reft in a
clofe veffel for four and twenty hours: If I then find a
precipitate formed, as it can be owing only to either fer-
ruginous falts, or to falts with a bafe of magnefia or
alumina, I examine its nature by the different operations
mentioned above, under the account of the trial by lime.
But as ammoniac gas does not act in fo uniform a manner
as lime-water, which effects the fame decompofitions, it is
proper to obferve, that this gas is to be employed only
as an auxiliary, from which fuch accurate refults are not
to be expected as from the operation of the preceding
reagent.

After

After the falts with a bafe of aluminous earth or mag-nefia, have been difcovered with lime-water or ammoniac gas; potafh or foda will detect thofe having a bafe of lime, fuch as calcareous fulphate, and calcareous muriate. With this view, I precipitate a few pounds of the water which I examine, with either of thefe fixed alkalis in liquor, till fuch time as the water ceafe to be turbid. As the alkali decompofes falts having a bafe of alumi-nous earth, as well as thofe which owe their formation to lime;—if the precipitate refemble that which I ob-tained by the application of lime-water, in form, colour, and quantity, I prefume that the water contains no cal-careous falt; and this conjecture is ufually confirmed by a chemical analyfis. But when the mixture becomes much more turbid than that which was formed with lime-water, and when the fediment is more ponderous and copious, and fooner depofited; I then infer, that it contains lime with a mixture of magnefia, or alumina. I afcertain this, by treating the fediment by the differ-ent operations for the purpofe, already defcribed. It may be naturally conceived, that the iron precipitated by reagents, at the fame time with the falino-terrene fubftances, muft be diftinguifhable by its colour and tafte, and that the quantity of the metal feparated by thefe proceffes, muft be too fmall to have any influence on the refults.

I need not here explain what fubftances the fulphuric acid, the nitrous acid, nut-gall, and calcareous and alka-line pruffiates, are capable of precipitating, when ufed as reagents. What I have faid above on the general effects of thefe matters, may be confidered as fufficient. I fhall only add, that when mixed in a large pro-portion with mineral waters, they produce precipitates, from an examination of which we may afcertain the na-ture

ture and the proportions of their principles ; a procefs which has been performed by Meffrs Bergman and Gioanetti.

A confideration of the products which nitric folutions of filver or mercury produce in mineral waters, will detain us longer. Thefe are the beft reagents for examining large quantities of water, when we wifh to afcertain the nature of the acids which waters may contain. Mineral waters may be confidered as completely analyfed, when the acids which they contain are known : for the acids are generally combined with fome of the bafes liable to be detected by the preceding reagents. The colour, form, and quantity of the precipitates formed by folutions of mercury and filver, have hitherto been regarded by chemifts as indicating fufficiently the nature of the acids to which their formation is owing. A thick, weighty fediment, inftantaneoufly formed, indicates the prefence of the muriatic acid. If fcanty, white, and cryftallized, with nitrate of filver,—yellowifh and fhapelefs with nitrate of mercury, and in both inftances but flowly depofited, it is then to be afcribed to fulphuric acid. However, as thefe two acids are often found together in the fame water, and as alkali and lime likewife decompofe thefe folutions, the refults are rather uncertain, unlefs we attend at the fame time to the phyfical properties of the precipitates. They muft, therefore, be examined in a more particular manner. To this end, mix the folutions of filver and mercury with five or fix pounds of the water which you wifh to analyfe ; at the end of twenty-four hours, filtrate the mixtures, dry the fediments, and then treat them with the ufual procefses. On heating in a retort the precipitate produced by the nitric folution of mercury, the portion of that metal which combines with muriatic acid, volatilizes into mild

mercury ;

mercury; and that which is combined with fulphuric acid, remains at the bottom of the veffel, and is of a reddifh colour. Thefe two falts may be likewife diftinguifhed from each other, on this occafion, by the phænomena which they exhibit on burning coals. Sulphate of mercury exhales fulphureous acid, and takes a red colour; mercurial muriate remains white, and is volatilized without diffufing any fmell of fulphur. Thefe phænomena likewife ferve to enable us to diftinguifh fuch precipitates as may be formed by alkaline fubftances contained in waters; for alkaline fubftances never give out a fulphureous fmell, nor are they volatile without decompofition.

The precipitates produced by the combination of mineral waters with the nitric folution of filver, may be examined with the fame facility. Sulphate of filver is more foluble than muriate of filver; and thefe two falts are therefore feparable by diftilled water. Muriate of filver may be diftinguifhed by its fixity and fufibility, and ftill more readily by its being lefs decompofable than fulphate of the fame metal. Sulphate of filver, when put upon coals, exhales a fulphureous fmell, and leaves an oxide of filver, which may be melted without any addition. I am not to fpeak here of all the chemical proceffes which might be adopted to diftinguifh between, and to feparate thefe two falts of filver. It is enough, that fome of them are here defcribed.

§ VI. *Examination of Mineral Waters by Diftillation.*

DISTILLATION is ufed in the analyfis of mineral waters, to diftinguifh the gazeous fubftances which they may happen to contain. Thofe fubftances are either air, more or lefs pure, or carbonic acid, or fulphurated

ated hydrogenous gas. To diftinguifh the nature and the quantity of the gazeous fubftances contained in any mineral water,—take a few pounds of the water, and put them into a retort of fuch a fize that they may fill it only one half or two thirds full. To this veffel adapt a curve tube entering, by its other end, into a glafs filled with mercury. When the apparatus is thus difpofed, heat the retort till the water fairly boil, or till elaftic fluid ceafe to pafs into the glafs containing the mercury. When the operation is ended, abftract from the bulk of the gas obtained, the air that was contained in the empty part of the retort. The reft is the aeriform fluid that was contained in the mineral water, the nature of which may be foon known, by trying it with a lighted lamp, or tincture of turnfole, or lime-water. If it take fire, and emit a foetid fmell, it is fulphurated hydrogenous gas : If it extinguifh a taper, redden turnfole, and precipitate lime-water, it muft be carbonic acid : Laftly, if it maintain combuftion without exhibiting flame, if it be inodorous, and if it alter neither turnfole nor lime-water, it is then atmofpheric air. The atmofpheric air thus obtained from mineral waters may happen to be purer than the common air of the atmofphere. We can then judge of its purity from the manner in which it contributes to combuftion, or by mixing it with nitrous or hydrogenous gas in Meffrs Fontana and Voita's eudiometers. The procefs employed to obtain gazeous matters from mineral waters, is entirely the invention of modern chemiftry. Formerly, they for this purpofe ufed a wet bladder, which was fitted to the mouth of a bottle full of mineral water. The fluid was then fhaken ; and from the manner in which the bladder was fwelled, an idea was formed of the quantity of gas contained in the water. We know, at prefent, that

this

this operation is not to be depended upon ; for water never gives out all its gas without ebullition ; and the fides of a wet bladder alter the elaftic fluid which is obtained, and deftroy its nature. It is not neceffary to take notice, that the phænomena which take place in the water, when gas is feparated, fhould be carefully obferved ; and that when the tafte, the lightnefs, and the fparkling of the water, fhew it to contain a large proportion of gas, the quantity of it fubmitted to diftillation fhould then be proportionably fmaller.

Such is the operation recommended by modern chemifts for the extracting of elaftic fluids from waters. I fhall obferve, 1. That with refpect to acidulous waters, this procefs cannot be depended upon, without a very accurate calculation of the weight of the air, and the degree of preffure to which the elaftic fluid is expofed in the glaffes ;—and that, as it is very difficult to eftimate thefe with fufficient accuracy, the abforption of this acid by lime-water, as has been propofed by M. Gioanetti, appears preferable. 2. Though it be recommended by Bergman for the extracting of fulphurated hydrogenous gas from fulphureous waters, it will not anfwer this end ; for boiling heat decompofes this gas ; and it is likewife decompofed by mercury, which paffes into the ftate of æthiops, as foon as it comes into contact with this elaftic fluid. On this account, in my analyfis of the waters of Enghien, near Montmorency, I have propofed the ufe of litharge for the abforption of this gas in a cold ftate, and for purifying fulphureous waters from all the fulphur which they contain.

§ VII.

§ VII. *Examination of Mineral Waters by Evaporation.*

EVAPORATION is generally confidered as the moſt certain mode of obtaining all the principles contained in mineral waters. We have above obſerved, what we may here repeat, from the experiments of Meſſrs Venel and Cornette, that long boiling may happen to decompoſe faline matters diſſolved in waters; for which reaſon, we have rather recommended the uſe of reagents. Evaporation, however, affords ſo much additional information, when employed together with the analyſis by reagents, that it will be proper to give a particular account of the beſt method for conducting it.

As the purpoſe of this operation is, to obtain the fixed principles of mineral water, it is evident, that in order to diſtinguiſh the nature and proportion of thoſe principles, a certain quantity of the water muſt be ſubmitted to the operation; and accordingly, the weaker the proportion in which thoſe principles exiſt in the water, ſo much the more of that fluid ſhould be uſed. Twenty pounds of the water may be ſufficient, when it contains a good deal of faline matter. But when only a very ſmall proportion of ſuch matter appears to be diſſolved in it, a much larger quantity muſt be evaporated; at times, even no leſs than ſome hundred pounds. The nature and ſhape of the veſſels in which mineral waters are expoſed to evaporation, are not matters of indifference. Thoſe made of any metal, except filver, are liable to be altered by water: glaſs veſſels, again, of a certain ſize, are very likely to crack or ſplit: veſſels of very compact and well varniſhed earth, are the moſt ſuitable for this purpoſe, although, when the varniſhing cracks, they are liable to abſorb the faline matters. Veſſels of

porcelain, without a coating, would, no doubt, be the most anfwerable ; but thefe again are too dear. Chemifts have propofed different methods of evaporating mineral waters. Some advife to diftil them to drynefs in clofe veffels, that no extraneous fubftances from the atmofphere may mix with the refidue ; but this operation is too tedious. Others recommend evaporation by a moderate heat, not fufficient to make them boil ; as a boiling heat is believed to alter their fixed principles, and to deprive them always of a certain part of thofe principles. This is the opinion of Venel and Bergman. M. Monnet, on the contrary, would have us to boil the water ; as its motion, when boiled, prevents extraneous matters to infinuate themfelves from the atmofphere. Bergman, to avoid this inconvenience, directs us to cover the evaporatory veffel with a lid having a hole in the middle, through which the vapours may make their efcape. This laft method greatly retards the evaporation, as it diminifhes the furface of the fluid in fo confiderable a degree. It muft be employed, at firft, till the vapours become ftrong enough to remove the duft. But the chief difference among chemifts, in refpect to the mode of conducting this operation, is, that fome follow Boulduc in feparating the fubftances which are depofited as the evaporation goes on, in order to obtain each of the principles of the water in a pure, infulated ftate ; whereas others would have the evaporation carried on to drynefs, before any fuch feparation be attempted. I agree with Bergman, in thinking this laft method the moft expeditious and the moft certain : for whatever be the precautions adopted in following the former method, in feparating the different matters as they are depofited or cryftallized, they are never obtained pure, but always need to be examined by a farther analyfis. Befides, this method is ne-

ver exact, on account of the lofs occafioned by fo many filtrations: laftly, it is very difficult and perplexing, and renders the evaporation exceedingly tedious. Mineral waters fhould be evaporated to drynefs in glafs capfules, on a water-bath: it would be ftill better to ufe glafs retorts on a fand-bath.

During the courfe of this evaporation, different phænomena are obferved. When the water is acidulous, it appears full of bubbles, as foon as the heat begins to make an impreffion upon it: while the carbonic acid is difengaged, a pellicle and a fediment are formed, confifting of chalk and carbonate of iron: after the formation of thefe pellicles, there is a cryftallization of fulphate of lime: laftly, muriates of potafh and foda are cryftallized in cubes on the furface; and, to obtain the deliquefcent falts, the evaporation muft be continued to drynefs.

Let the refidue then be weighed, and put into a fmall phial, with three or four times its weight of alcohol. Shake the whole, and after letting it reft for a few hours, filtrate it; preferve the liquor apart, and dry, by a gentle heat, or in the air, that portion of the refidue on which the fpiritous fluid has not acted. When fufficiently dry, it is to be carefully weighed; and the lofs which it has fuffered fhews what quantity of calcareous or magnefian muriate it contained, as thefe falts are very foluble in alcohol. We will fpeak afterwards of the method of afcertaining the exiftence of thefe two falts in this fpiritous fluid.

The refidue, when properly dried, is next to be diluted with eight times its weight of cold diftilled water; and this mixture, after being left to fettle for feveral hours, muft be filtrated. The refidue is again dried, and then boiled half an hour in four or five hundred

times

times its weight of cold diftilled water. It is next to be again filtrated ; and after this laft operation, there remains only what the cold water and the boiled water have been infufficient to diffolve. The cold water would take up the neutral falts, fuch as fulphate of foda or magnefia, muriate of foda or potafh, and fixed alkalis, efpecially foda combined with carbonic acid. Boiling water in a large proportion, diffolves only fulphate of lime. There are therefore four fubftances to be examined after thefe different operations on the matter obtained by evaporation : 1. The refidue which is infoluble in alcohol, and in water in different temperatures : 2. Salts diffolved in alcohol : 3. The falts which have been taken up by the cold water : 4. Laftly, Thofe which have been taken up by the boiling water. We now proceed to the experiments for diftinguifhing thefe different fubftances.

1. The refidue which has withftood the action of alcohol, and of cold and hot water, may confift of carbonate of magnefia and iron, of alumina, and of quartz. The two laft of thefe fubftances are very rarely to be found in waters, but the three firft are very common. A lighter or deeper brown or yellow colour, indicates the prefence of iron. When the colour of the refidue is a light grey, it contains no iron. When it contains any of that metal, Bergman advifes to moiften it, and expofe it to the air till it ruft. Vinegar then no longer acts upon it. To explain the methods for feparating thefe different matters, let us fuppofe an infoluble refidue, confifting of all the five fubftances which we have allowed that it may contain. We muft begin with moiftening and expofing it to the rays of the fun. When the iron is fufficiently rufted, the refidue may be digefted in diftilled vinegar. This acid diffolves the lime and magnefia.

magnefia. By evaporating the mixture, we obtain calca-
reous acetite, which is diftinguifhed from acetite of mag-
nefia by not attracting moifture from the atmofphere.
Thefe two falts may be feparated by deliquefcence, or
rather by pouring fome fulphuric acid into the folution
containing them. The fulphuric acid forms fulphate of
lime, which is precipitated : if there were any magne-
fian acetite, the fulphate of magnefia, formed by the
fulphuric acid, would remain diffolved in the liquor, and
might be obtained by an evaporation judicioufly con-
ducted. To afcertain the quantity of the magnefian and
calcareous earths contained in this refidue, precipitate the
fulphates of lime and magnefia formed by the fulphuric
acid poured into the acetous folution with carbonate of
potafh, and weigh the precipitates. When the chalk and
magnefia of the refidue are feparated, only iron, alu-
mines and quartz remain. The iron and alumines are
detached by means of pure muriatic acid, which diffolves
both thefe falts. The iron is precipitated by pruf-
fiate of lime, and the alumines by carbonate of potafh :
the two fubftances are then weighed to determine the
quantities. The matter which remains after the fepara-
tion of the alumines and the iron, is ufually quartzofe.
Its quantity is afcertained by weighing it ; and its na-
ture, by melting it with carbonate of foda, by means of
the blow-pipe. Thefe are the moft accurate proceffes
which have been recommended by Bergman, for the
examination of the infoluble refidue of mineral waters.

2. The alcohol which was ufed in wafhing the dry
refidue of the waters, is next taken and evaporated to
drynefs. Bergman directs to treat it with fulphuric acid
diluted in water, in the fame manner as the acetous fo-
lution above taken notice of. But it is to be obferved,
that by this procefs only the bafe of thofe falts is difco-

vered.

vered.   To determine the nature of the acid, which is usually united with magnesia or lime, and sometimes with both in this residue, we must pour upon the dry residue a few drops of strongly concentrated sulphuric acid, which produces an effervescence, and disengages muriatic acid gas, that makes itself known by its smell and white vapour, when the salt under examination owes its formation to that acid.   Its existence may likewise be ascertained, by dissolving the whole residue in water, and mixing with it a few drops of the nitric solution of silver.   With respect to the base, which, as we have already mentioned, consists either of lime or of magnesia, or of both ; the quantity and the nature of its principles may be also determined by sulphuric acid, by the same process which has been explained above in speaking of the application of the acetous acid.

3. The lixivium of the former residue of the mineral water, prepared with eight times its weight of cold distilled water, contains alkaline neutral salts,—such as sulphate of soda, muriates or marine salts, carbonate of potash or soda, and sulphate of magnesia.   Sometimes, too, there is a small quantity of sulphate of iron.   These salts never exist altogether in mineral waters.   Sulphate of soda and carbonate of potash, are but very seldom found in mineral waters ; but marine salt is often found in them, in union with carbonate of soda.   Sulphate of magnesia likewise exists pretty often in such waters ; and they are even sometimes found to contain it in a pretty considerable quantity.   When this first washing of the residue of a mineral water contains only one neutral salt ; that salt may be very easily obtained by crystallization, and its nature may be known by its form and taste, and by the manner in which it is affected by fire and reagents.   But this case is very rare ; and it

happens

happens much more frequently, that a number of falts are united together in this lixivium : We muft then endeavour to feparate them by flow evaporation. Even this method does not always fully fucceed, with whatever care this firft lixivium may be evaporated : each of the falts obtained at different times by evaporation, muft be examined anew. It is moft commonly carbonate of foda which is depofited in a confufed manner among the muriatic falts. Thefe may be feparated by a procefs defcribed by M. Giaonetti : It confifts in wafhing this mixed falt with diftilled vinegar ;—that acid diffolves the carbonate of foda : Dry the mixture, and wafh it anew with alcohol ;—the alcohol takes up the acetite of foda, without acting upon the marine falt : Evaporate the fpiritous folution to drynefs, and calcine the refidue ;—the vinegar is decompofed and burnt. Nothing remains after this but foda, the exact quantity of which is known.

4. The lixivium of the firft refidue of mineral water, prepared with four or five times its weight of boiling water, contains nothing but fulphate of lime. Accordingly, pure cauftic ammoniac produces no change upon it ; but cauftic potafh forms in it a copious precipitate. By evaporating the lixivium to drynefs, the quantity of terrene falt which it contains is exactly known.

§ VIII. *Of Factitious Mineral Waters.*

THE procefles which have been defcribed for the examination of the refidues obtained by the evaporation of mineral waters, are fufficient for difcovering, with the utmoft accuracy, whatever different fubftances may be diffolved in thofe fluids. Yet we muft ftill advance a ftep farther, in order to confirm the refults of our analy-

lyfis :

lyfis: We muft imitate nature by a fynthetic procefs, and diffolve in pure water the feveral fubftances obtained by analyfis, from the mineral water which we have been examining. If the factitious mineral water thus formed, have the fame tafte and weight, and exhibit the fame phænomena with reagents as the natural mineral water which was analyfed,—no fuller proof can be required of the accuracy of the analyfis. Such artificial combinations happily fupply, at all times, in all places, and at a fmall expence, medicines equally ufeful for the cure of difeafes with natural mineral waters, whofe properties are liable to be altered by conveyance from one place to another, and by many other circumftances.

The moft celebrated chemifts are of opinion, that natural mineral waters may be imitated by art. Macquer obferves, that fince the difcovery of the carbonic acid, and fince its power of rendering a great many fubftances foluble in water has been taken notice of, it is become much eafier to prepare factitious mineral waters. Bergman has given directions for the preparation of factitious Spa, Seltz, Pyrmont, &c. waters. In Sweden, he informs us, fuch waters are ufed with great fuccefs; and he himfelf had experience of their good effects. M. Duchanoy has publifhed a work, in which he gives a feries of proceffes for the artificial preparation of all the mineral waters ufed in medicine. We have therefore good reafon to hope, that chemiftry may render the art of medicine fome important fervices, by fupplying fuch valuable medicines, and by weakening and increafing their energy at pleafure.

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ON

MODERN CHEMISTRY *in General, and on its* FIRST PRINCIPLES.

IN tracing the hiſtory of chemiſtry for theſe laſt twenty years, we find, that, in conſequence of the diſcovery of the different elaſtic fluids, and their properties, Stahl's theory has loſt much of its credit: Chemiſts have been for ſome time in doubt, whether to reject or adhere to it, and have formed various theories,—the number of which is ſcarce inferior to that of thoſe who are ſeriouſly engaged in the purſuits of this ſcience. A good many chemiſts, however, eſpecially in the north, have not yet adopted any new theory, but continue to connect the theory of Phlogiſton with the newly diſcovered facts. But thoſe who are maſters of the ſcience in all its extent, muſt readily perceive, that the manner in which that connection is formed, is far from being natural or ſatisfactory ; and that it conſiſts of forced analogies, the inconſiſtency of which is ſufficiently ſtriking.

The doctrine adopted by ſeveral French chemiſts, at the head of whom we muſt rank M. Lavoiſier, who contrived and laid the foundations of this ſyſtem, is not ſubject to the ſame difficulties. Its ſimplicity, its ſyſtematic

progreſs,

progrefs, its perfpicuity, and the eafe with which it is applicable to all the phænomena of chemiftry, render it much fuperior to any of thofe which ftill divide fuch of the philofophers of Europe as have not adopted it. This doctrine has been particularly explained through the whole of this work : But perhaps a fhort view of it may ftill be of ufe to the ftudent ; and I have therefore endeavoured to exhibit, in the following Difcourfe, a brief account of the principles on which it is founded ; which may render it more ftriking, and more eafily intelligible, and which will accordingly be a fort of abftract of all the leading phænomena, to which the others may be referred as to fo many general heads.

In all chemical experiments, one of the two following phænomena is obferved : 1. Heat is either difengaged or fixed : 2. An elaftic fluid is either formed or abforbed. After thefe two general facts are eftablifhed as invariably certain, it may be naturally conceived, that the properties and action of heat, with the formation and fixation of elaftic fluids, are the foundation of the theory of chemiftry. Thefe, therefore, are the two great objects which muft here engage our attention.

Of Heat, and of the Formation and Fixation of Elaftic Fluids.

ALTHOUGH the weight, both of fenfible heat, and of combined or latent heat, which we have denominated *caloric*, is at prefent unknown, and cannot therefore afford any proof of its material or individual exiftence, yet the whole phænomena of chemiftry concur to prove, that it exifts as a feparate body or fubftance, poffeffes certain unvarying properties or characteriftics, and

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is uniformly subject to certain laws of affinity. Besides its power to produce, by its action on our organs, that sensation which we denominate *heat*, philosophers have observed it to possess certain distinctive properties which can belong to no other substance, such as rarefaction, or the separation which heat produces of the component particles of all natural bodies; which, by increasing their bulk, diminishes their reciprocal attraction, and, without enlarging the mass, diminishes, in the same proportion, their specific gravity, and strengthens the affinities between the component particles of different bodies. The greater the quantity of caloric accumulated in any body, the more is that substance compressed and condensed; so much the more is its affinity for that body increased; and in the same proportion, too, are the properties of the body changed. Fusion or liquefaction, volatilization or sublimation, the passage of liquids into the form of vapours or elastic fluids,—are effects constantly produced by the penetration of heat into those bodies, or rather by its combination with them. Ice, or water in a solid state, becomes fluid by absorbing a certain quantity of caloric: A larger proportion of the same principle renders it invisible and aeriform. There can be no doubt, that water in a liquid state is a compound of ice with a certain quantity of caloric, and that water in gas or vapour, is equally a compound, of which the principles are the same, but which contains caloric in a larger proportion. Such is the theory of the formation of elastic fluids in general: They are all compounds, consisting of a base more or less solid, and matter of heat or caloric. As this last principle is subject to laws of attraction peculiar to itself; when it escapes from one body, it combines with some other:—or ra-

ther,

ther, bodies with which caloric is combined, when they have a ftronger attraction for other bodies exhibited to them than for this principle, difmifs it, in order to combine with thofe other bodies.

There is not a fingle inftance in which thefe phæno-na of the difengagement or fixation of caloric, and the difengagement or fixation of elaftic fluids are not obferv-ed, either feparately or together. From this fimple the-ory, which is in reality nothing but a ftatement of facts, it appears that all elaftic fluids ought to be diftinguifhed by two names ; one denoting their aeriform combination with caloric,—of which fort are the generic words, *air*, or *gas*, the firft to be ufed when thofe fubftances are proper for maintaining combuftion and refpiration, the fecond when they do not contribute to thefe purpofes; the other, a fpecific name, denoting the particular bafe of the gas or elaftic fluid. It will accordingly be ex-pected, that, in a recapitulation of all the facts of che-miftry, we fhould give an account of the elaftic fluids which are either produced and difengaged, or fixed and abforbed in the various phænomena belonging to this fcience.

All the elaftic fluids whofe properties are worthy of notice, may be arranged in four claffes.

Class I.

Elaftic Fluids capable of maintaining Combuftion, and the Refpiration of Animals.

Species 1. Vital air.
   2. Atmofpheric air.

CLASS II.

Elastic Fluids unfit for maintaining Combustion and Respiration, and neither saline nor soluble in Water.

Species 3.   Azotic gas.
     4.   Nitrous gas.

CLASS III.

Elastic Fluids unfit for maintaining Combustion and Respiration, but of a saline Nature, and soluble in water.

Species 5.   Carbonic acid gas.
     6.   Sulphureous acid gas.
     7.   Fluoric acid gas.
     8.   Muriatic acid gas.
     9.   Oxigenated muriatic acid gas.
    10.   Ammoniac gas.

CLASS IV.

Elastic Fluids neither proper for maintaining Combustion, nor Respiration, but inflammable.

Species 11.   Hydrogenous gas.
    12.   Sulphurated hydrogenous gas.
    13.   Phosphorated hydrogenous gas.
    14.   Hydrogenous gas mixed with azote.
    15.   Hydrogenous gas mixed with carbonic acid.
    16.   Carbonaceous hydrogenous gas.

Of

Of the Nature and leading Properties of thefe different Species of Elaftic Fluids.

I. *VITAL AIR*, called by its difcoverer, Dr Prieftley, *dephlogifticated air*, and by fome other Englifh philofophers, *empyreal air*, and *principium forbile*, is at prefent extracted from many different matters. *Precipitate per fe*, or oxide of mercury, prepared by nitric acid, precipitates of the feveral mercurial neutral falts formed by alkalis, red oxide of lead fprinkled with a little nitric acid, alkaline and terrene nitrates, nitrate of filver, native oxide of manganefe either by itfelf or fprinkled with fulphuric acid, oxigenated muriatic acid, mercurial acetite, arfeniate of zink, all give out either more or lefs of it when expofed to the action of light and heat. Its difengagement is evidently effected by the uniform action of thefe two principles. It is not contained ready formed in thefe bodies : they contain only its folid bafe, which is melted by caloric and light, and thus reduced into an elaftic-fluid ftate ; and as it efcapes, the oxides by degrees affume the metallic ftate. It is alfo obtained from the leaves of plants or trees expofed in water charged with carbonic acid to the action of the rays of the fun.

Vital air is often mixed with a little azotic gas ; only, that obtained from oxide of mercury, from oxide of manganefe, or from the leaves of plants, is without it.

Vital air is rather heavier than atmofpheric air ; it is the only elaftic fluid which maintains combuftion. Pure vital air is four times as powerful for this effect as atmofpheric air ; that is to fay, a body requiring four cubic feet of atmofpheric air to effect its combuftion, may be burnt with one cubic foot of vital air. Combuftion is accompanied with a good deal of light and heat : thefe

two

two phænomena are occafioned by the rapid feparation of the fire, which forfakes the bafe of this air in proportion as that bafe fixes in the burning body. In fome inftances of combuftion effected by this air, only heat, but no light, is difengaged. This happens when the difengagement is accomplifhed flowly and by degrees. It contributes alfo in an eminent manner to refpiration. But as there is fo much heat difengaged from it, it would appear, that the refpiration of pure vital air would be injurious to animals: the blood would be too much rarified by it, and its circulation rendered too rapid.

The bafe of vital air, by combination with carbone, fulphur, phofphorus, azote, arfenic, &c. forms the carbonic, fulphuric, phofphoric, nitric, arfenic, &c. acids. It is from its poffeffing this property, that we have denominated this bafe oxigene, or the acidifying principle. It is to be obferved, 1. That thefe combinations do not always take place when thofe combuftible bodies are immerfed in vital air; and that different degrees of temperature, above the ordinary temperature of the atmofphere, are generally requifite to produce them, at leaft with fufficient rapidity. 2. That this bafe or oxigene enters into thefe compounds in different proportions; and that, according as any bafe is more or lefs completely faturated, the compound differs in its nature from other compounds not faturated precifely in the fame degree. 3. That its affinity for thefe different matters is not uniformly the fame: accordingly, phofphorus robs the arfenic acid of its oxigene; the phofphoric acid, again, yields its oxigene to coal, &c. 4. That when it paffes out of one of thofe bodies in which it has been fixed in a ftate very different from that of elaftic fluidity, into any other body, a fort of combuftion actually takes place; which is indeed very flow, and therefore unaccompanied with either.

heat

heat or light; as oxigene, in the ſtate in which it exiſts in ſuch bodies, is combined with but very little of thoſe principles.

Oxigene combined with hydrogene, forms water; with metals, it forms metallic oxides.   Coal decompoſes water and metallic oxides; having a greater affinity with oxigene, than either hydrogene or metals.

Vital air diſcolours vegetable and animal ſubſtances: When abſorbed by fixed oils, it thickens them, and reduces them into a ſtate reſembling that of wax.   With the muriatic and the acetous acids, it forms oxigenated muriatic acid or radical vinegar.

The heat of the ſun, when acting with any conſiderable energy, diſengages oxigene into the ſtate of vital air from many of its combinations; ſuch as the oxides of mercury, ſilver, gold, nitric acid, oxigenated muriatic acid, &c.

II. *Atmoſpheric* or *common air* is a compound of vital air with azotic gas.   One hundred parts of atmoſpheric air, contain nearly 72 parts of azotic gas and 28 parts of vital air.   This explains the reaſon why only a fourth part of any quantity of atmoſpheric air is conſumed before it becomes unfit for maintaining combuſtion; and why the phænomenon of combuſtion takes place more ſlowly, and is accompanied with leſs heat and light in atmoſpheric, than in pure vital air.   But we muſt obſerve, that there is not perhaps a ſingle inſtance of combuſtion, in which the 28 parts of vital air contained in the common air of the atmoſphere, are entirely abſorbed and fixed in the combuſtible body; and that accordingly, the aeriform reſidue of atmoſpheric air remaining after it has contributed to combuſtion, is ſcarce ever pure azotic gas, not even when the burnt body remains in a fixed and

ſolid

solid state, without mixing with the elastic fluid. The gas must therefore be still more impure, when the body is burnt under a bell-glass filled with atmospheric air, and affords a residue in a permanent aeriform state; as charcoal, and all organic matters containing it, do.

There are a number of bodies which alter atmospheric air, by absorbing the vital air which it contains. But we know of none that renew and purify it, except the leaves of vegetables; which, when exposed to the rays of the sun, effect a decomposition of carbonic acid and water, in consequence of which, they afford a supply of vital air to the atmosphere.

III. *Azotic gas*, which exists in the atmosphere in a large proportion, is thus named, because it very soon proves fatal to animals, and extinguishes combustion; and accordingly, appears to be in its nature directly opposite to vital air. Dr Priestley called this elastic fluid *phlogisticated air;* imagining that it derived its noxious properties from phlogiston, disengaged out of burning bodies, or odorate matters;—in a word, from all those operations of nature and art, which he has called *phlogisticating processes.*—It has since been proved, that this fluid exists ready formed in the atmosphere, and is only separated by the absorption of vital air. Modern philosophers have made more important discoveries concerning this, than concerning any other elastic fluid.—There are several ways of obtaining pure azotic gas. That which is most generally in use, is the exposing of a quantity of liquid sulphure of potash to a given quantity of atmospheric air under bell-glasses: the vital air is by degrees absorbed; and when *it* is entirely absorbed, the azotic gas remains pure. We owe this process to Scheele. M. Berthollet has discovered, that it may also be obtain-

ed, by treating mufcular flefh, or the fibrous part of the blood, after having wafhed it well with nitric acid, in an apparatus fuitable for collecting and preferving gafes: but thefe animal matters, when ufed for this purpofe, muft be perfectly frefh : if altered, they afford, together with the azotic gas, a mixture of carbonic acid. I myfelf have difcovered, that the air-bladder of the carp, which Dr Prieftley had before obferved to contain noxious air, is full of this fluid, which may be obtained fimply by burfting them under bell-glaffes filled with water.

Azotic gas is lighter than atmofpheric air. It inftantly extinguifhes burning tapers; and acts, with great rapidity and energy, in deftroying the life of animals immerfed into it. When mixed with vital air, in the proportion of 72 to 28, it affords factitious atmofpheric air : in a larger proportion, it forms an air noxious to animals. Neither water, nor earths, nor acids, are known to act upon this gas : It appears, however, that it is liable to be abforbed by the nitric acid, which it renders ruddy. Mr Cavendifh has difcovered, that three parts of azotic gas, mixed in glaffes with feven parts of vital air, and expofed to the action of the electric fpark, are by degrees condenfed, fo as to form nitric acid : Hence the theory of the formation of this acid in the atmofphere. M. Berthollet has found, that ammoniac is decompofed by hot nitric acid, by oxigenated muriatic acid, and by the detonation of fulminating gold. He has difcovered, that ammoniac confifts of five parts of azote, and one of hydrogene. He has farther difcovered, that animal matters contain a great deal of azote,—that the ammoniac obtained from them by the action of fire and putrefaction, is formed by the union of that azote with hydrogene,—and that plants, which afford this fame falt by diftillation, afford it in confequence of their containing

azote,

azote, and therefore well deserve the name of *animal plants*, which has been given them by some chemists. I have since satisfied myself by experiment, 1. That of all animal matters, the fibrous part affords the most azotic gas by nitric acid ; 2. That after putrefaction, it contains no more azote, but becomes capable to afford a considerable quantity of ammoniac.

These remarkable qualities of azotic gas, are particularly worthy the attention of the physician. They contribute to explain the difference between animal and vegetable matters, the formation of ammoniac putrefaction, and the production of the nitric acid from putrid animal matters.

As this elastic fluid has been by some people confounded with carbonic acid, it is to be remembered, that azotic gas has no sensible taste,—is much lighter than that aeriform acid,—and neither reddens tincture of turnsole, nor precipitates lime water.

IV. *Nitric gas* was in some measure known to Hales ; but Dr Priestley is properly the discoverer of it. This elastic fluid is disengaged from nitric acid by the action of a great number of combustible bodies, especially metals, oils, mucilages, and alcohol. It extinguishes lights ; it destroys animals ; it is neither acid nor alkaline ; it is not liable to be altered by pure water. By combination with vital air, it affords nitric acid ; being itself nothing but nitric acid, deprived of a part of its oxigene, and consequently a compound of azote and oxigene,—only, containing more azote and less oxigene than the nitric acid. Hence the varieties of this gas, according as azote and vital air are mixed in it in different proportions ; and hence the uncertainty of its effects on the eudiometer. From this we understand, why, in several instances,—especially when,

in order to obtain nitrous gas, we ufe a body very greedy
of oxigene, and requiring a confiderable quantity of oxi-
gene to faturate it,—the nitrous gas obtained, contains
naked azotic gas; and even, fometimes, nothing is obtain-
ed but azotic gas.   Laftly, It is in confequence of nitric
gas poffeffing this property, that fulphure of potafh is
enabled to act upon it with fuch energy.   A folution of
fulphure of potafh, when put into a glafs filled with ni-
trous gas, immediately abforbs a part of the gas: In a
fhort time, the gas is no longer reddened by the contact
of air, and becomes fit for maintaining combuftion, even
better than atmofpheric air.   It is actually converted in-
to air, fomewhat purer than the air of the atmofphere, or
containing a larger proportion of vital air than atmofphe-
ric air ufually contains : But if more nitrous gas be add-
ed, and the action of the fulphure ftill continued, the
whole of the vital air is foon abforbed, and what remains
is nothing but azotic gas.   We may farther obferve, that
nitrous gas communicates to phlegm a green colour, be-
fore extinguifhing it ; and that, in many inftances, its co-
lour is owing to compounds, of which azote forms a part.

Thefe leading properties of nitrous gas, particularly
the rapidity of its combination with vital air, fhew, that
it bears an analogy to combuftible bodies; and it has
been obferved by Macquer, that the artificial formation
of nitrous acid by the mixture of thefe two gafes, is a
fpecies of combuftion ; but as it is not accompanied with
phlegm, I have not ventured to rank nitrous gas among
the inflammable gafes.

V. *Carbonic acid gas* was known before any of the o-
ther elaftic fluids.   Dr Black difcovered its exiftence in
chalk and alkalis ; and at the fame time fhewed, that it
rendered thofe matters effervefcent, mild, and fufceptible

of cryftallization; and that, when deprived of it, alkaline matters become acrid and cauftic, and are nō longer liable to effervefce, &c. This gas exifts in the atmofphere, of which it compofes nearly one two-hundredth part; in acidulous waters, and in fome fubterraneous cavities, fuch as the *Grotto del Cano,* &c. It is nearly twice as heavy as atmofpheric air; its fmell is pungent, and its tafte acrid; it extinguifhes burning bodies,—kills animals,—reddens tincture of turnfole,—precipitates lime-water,—renders chalk foluble in water,—forms, with all alkaline matters, carbonates, a fort of cryftallizable neutral falt, in which the properties of the alkali are ftill difcernible, on account of the weaknefs of the acid. This acid gas, which acts an important part in the phænomena of nature and art, is a compound of carbone and oxigene; of carbone, in the proportion of twenty-eight hundredth parts,—and oxigene, in the proportion of feventy-two hundredth parts. As carbone, of all known bodies, appears to have the ftrongeft affinity for oxigene, the carbonic acid is among thofe compounds, of which the decompofition is the moft difficult, and one of the products the moft frequently obtained in chemical analyfes. It is formed in all inftances in which bodies containing oxigene are heated with coal; as in the reduction of metallic oxides by oils,—in coal itfelf, &c.—by the decompofition of organic matters containing coal and water, &c.

VI. *Sulphureous acid gas* is obtained, either by the flow combuftion of fulphure, or by abftracting from fulphuric acid a part of its oxigene; and is a compound of fulphure with oxigene, containing the latter principle in a more fcanty proportion than fulphuric acid. This gas has a fulphureous fmell, acrid and pungent, and a very four tafte; it extinguifhes burning bodies, and kills ani-

mals;

mals : Intenfe cold condenfes it into a liquid ftate : It reddens and difcolours moft vegetable blue colours : it combines with water and with ice, and melts the latter of thefe fubftances by means of the heat which it gives out as it becomes fixed : it abforbs, by degrees, oxigene from the atmofphere ; and, in confequence of that, paffes into the ftate of fulphuric acid.

VII. *Fluoric acid gas* is difengaged from native fluate of lime, or *vitreous fpar*, by fulphuric acid. Its fmell and tafte are very ftrong : it diffolves filiceous earth, and holds it fufpended in an aeriform invifible ftate. The contact of water, by fixing it, feparates a portion of that earth : Alkalis feparate it entirely. The nature of this acid gas is unknown ; and if it be like moft other mineral acids, a compound, confifting of a fimple acidifiable bafe with oxigene, its acidifiable radical principle muft have a very ftrong affinity with oxigene ; for even coal is not able to decompofe this gas, by detaching that principle.

VIII. *Muriatic acid gas* is nothing but muriatic acid, purified from water, and melted by caloric into an elaftic fluid. Its fmell, which is lively and fuffocating,—its tafte, which is very ftrong,—its folubility in cold water, which readily abforbs it, and feparates the heat by which it was maintained in a ftate of elaftic fluidity,—the peculiar neutral falts which it forms with terrene and alkaline bafes,—and the white vapour which is obferved whenever it comes into contact with water diffolved in the atmofphere,—are its diftinguifhing characteriftics. Its intimate nature, or component principles, are unknown ; its acidifiable bafe has undoubtedly a very ftrong affinity with oxigene, as thefe principles have never yet been feparated. Nay, we are about to fee, that this acid abftracts

oxigene

oxigene from various other bodies, when they are faturated with it.

IX. *Oxigenated muriatic acid gas* is difengaged with great facility during the reciprocal action of native oxide of manganefe and muriatic acid. This peculiar gas is known to be produced by the tranfition of oxigene from the manganefe into the muriatic acid. This gas always retains a colouring part, of a greenifh yellow: Its fmell is ftrong and pungent: It is not acid: It weakens and reddens the flame of a taper, but does not extinguifh it: It is very quickly fatal to animals: It difcolours ftuffs, tincture of turnfole, and flowers, rendering them all white: It likewife difcolours and whitens yellow wax, &c.: It decompofes ammoniac, which may now be ufed as a prefervative againft its noxious effects: the azotic gas of the ammoniac is feparated, while the oxigene of the muriatic gas combines with its hydrogene to form water: It condenfes fixed oils: It oxidates metals; and even mercury and gold are fubject to its influence: It is foluble in water, and communicates to that fluid all its properties: The contact of light by degrees decompofes it, and reduces it into the ftate of pure muriatic acid.—The formation of oxigenated muriatic acid, and oxigenated muriatic acid gas, is one of the moft remarkable difcoveries of modern chemiftry. This difcovery fhews, that the relations of muriatic acid to combuftible bodies are directly contrary to thofe of the other acids. All the other acids appear to be decompofable by moft of the metals, which have in general a ftronger affinity with oxigene than the combuftible bafes of thofe acids have. The muriatic acid, on the contrary, is not decompofed by any metal: none of them detaches its oxigene; and in confequence of this, it fcarce acts on any.

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of

of the metals. Its bafe, which is ftill unknown, is not only intimately connected with the acidifying principle, but even detaches that principle from feveral other metallic oxides, as well as from oxide of manganefe ; when faturated, it is no longer acid ; as excefs of oxigene deftroys its acidity. The cafe is directly contrary with many other combuftible bodies. Its excefs of oxigene enables it to act upon metals, on which, in its ordinary ftate, it produces no change ; fuch, particularly, are antimony, filver, and gold. While thefe metals rob it of this excefs of oxigene, they are by degrees burned, and diffolved in the muriatic acid, which returns itfelf into its original ftate. Thefe oxidations and folutions of metals, by the oxigenated muriatic acid, are accomplifhed without effervefcence, in the fame manner as a falt is diffolved in water ; for the metal takes up the fuperabundant oxigene of the liquid acid quietly, and with much more eafe than if it were obliged to difengage it from a combuftible bafe. Oxigenated muriatic acid likewife diffolves metallic oxides, and thereby forms oxigenated muriates, very different in their nature from fimple muriates. The moft ftriking and moft remarkable of thefe differences appears in the combinations of the acid, in its different ftates, with oxide of mercury. With oxigenated muriatic acid, oxide of mercury forms *corrofive fublimate*. With fimple muriatic acid, the fame oxide forms *mild mercury*. The differences between thefe two falts are therefore owing to the differences between the two ftates of the acid in refpect to the proportions of the oxigene.

X. *Ammoniac gas*, difcovered by Dr Prieftley, is difengaged by heat from liquid ammoniac, and, with ftill more rapidity, from a mixture of ammoniacal muriate, or
<div align="right">common</div>

common fal ammoniac, with quicklime. This elaftic fluid, when collected in glaffes over mercury, is found to be a little heavier than atmofpheric air. The degree of cold or preffure at which it lofes its aeriform fluidity, is ftill undetermined. It combines with water, giving out, while the combination takes place, a good deal of heat: it melts ice: it renders fyrup of violets, as well as blue and red flowers, green: it combines rapidly with carbonic, fulphureous, and muriatic acid gafes; thefe combinations produce a good deal of heat: as this heat is difengaged from the two elaftic fluids, thefe become folid while the combinations are forming.

Ammoniac gas is fpeedily decompofed by the contact of oxigenated muriatic acid gas: the decompofition is accompanied by heat: a quantity of water, charged with muriatic acid, is formed, and there is a refidue of azotic gas. This experiment, as well as feveral others which have been already mentioned, proves ammoniac to confift of hydrogene and azote. The decompofition of ammoniacal copper, and of *fulminating gold* and *filver*, which afford, by the action of fire, water, reduced metal, and azotic gas, is another proof that ammoniac confifts of thefe principles; for, the hydrogene of this alkali having a ftronger affinity for oxigene than either gold or filver, detaches it from the oxides of thefe metals, and, leaving its azote to be difengaged into a gazeous ftate, forms water with the oxigene which it has acquired in this manner. The phænomena of this decompofition of ammoniac by oxides, are very much diverfified—from that which oxide of copper effects flowly, and with the affiftance of a ftrong heat,—to the amazing rapidity with which ammoniacal oxide of filver is reduced, when it detonates by the momentary contact of heat. The diver-

fity of thefe phænomena is owing to the various affinities of oxigene with the different metals.

Oxides of zinc and iron, which, in their metallic ftate, decompofe water, have not the fame power over ammoniac; for thefe metals have a greater affinity with oxigene, than oxigene has with hydrogene.

XI. *Pure hydrogenous gas,* univerfally known by the name of *inflammable air,* is the lighteft of all aeriform fluids: When very pure, it is thirteen or fourteen times lighter than atmofpheric air. It extinguifhes burning bodies: it kills animals: it is kindled by the contact of the electric fpark, or of any flaming combuftible body: it burns with a bright flame. Fifteen parts of this gas abforb, in burning, eighty-five of vital air; and by that combuftion, an hundred parts of very pure water are formed—if the elaftic fluids be pure. The water is therefore a compound of thefe two bodies, deprived of moft of the heat which is neceffary to maintain them in the ftate of elaftic fluidity. All fubftances having a ftronger affinity with any one of thefe two principles, than that by which their union is maintained, decompofe this fluid. Thus, iron, zinc, coal, and oils, decompofe water, and feparate hydrogene from it into a gazeous ftate; as they have a ftronger affinity with the bafe of vital air or oxigene than it has with hydrogene. From this it is clear, that hydrogenous gas cannot be expected to decompofe carbonic acid, or the oxides of zinc and iron: On the contrary, fulphur, and fuch metals as do not decompofe water, give up the oxigene which they contain, in the ftate of fulphuric acid, and of metallic oxides, to hydrogenous gas; which reduces the former into the ftate of pure fulphur, and the latter into the ftate of metals. This decompofition of water by

iron

iron and zinc, is the caufe from which proceeds the hy-
drogenous gas produced during the folution of thefe two
metals by the fulphuric, the muriatic, the carbonic, or
the acetous acid.

The leaves of vegetables, on the contrary, appear to
poffefs the property of abforbing the hydrogene of wa-
ter, and difengaging its oxigene into the ftate of pure air.
Light contributes greatly to this decompofition; and
without the contact of light it is never effected. It ap-
pears to ferve for the purpofe of melting oxigene, and thus
forming it into vital air; and, while the oxigene is dif-
engaged, the hydrogene becomes fixed in the vegetable,
and ferves, no doubt, for the production of oil. We
know not yet exactly, with what fubftances, and in what
proportion, hydrogene muft combine to form oil. Hy-
drogene, or the bafe of hydrogenous gas, forms ammo-
niac, by combination with azote, or the bafe of azotic
gas. M Berthollet, by analyfing that falt, has fhewn
this to be its compofition: But we have not yet been
able to form ammoniac by the immediate combination of
thefe two principles.

We have never yet been able to feparate the matter
of heat combined in hydrogenous gas, to which that
gas owes its elaftic fluidity, without fixing the hydro-
gene in fome other compound; and therefore, we are
ftill unacquainted with hydrogene in a folitary infulated
ftate. The degree of preffure or cold neceffary to effect
this feparation, muft be fuch as we have not yet learned
to apply: Every thing, indeed, concurs to fhew, that
either the one or the other muft be in an extreme de-
gree.

The fudden difengagement, and the rapid inflamma-
tion of hydrogenous gas, produce all the fulminations
and detonations which are obferved in chemiftry. The

inftantaneous

inftantaneous recompofition of water is almoft invariably the confequence of thefe detonations.

Hydrogenous gas performs an important part in the phænomena of nature. A great quantity of it is produced and difengaged in mines: It there reduces and colours various metallic oxides: it rifes in the atmofphere, is carried about by the winds, and kindled by the electric fpark: accordingly, it acts the part of thunder; and immediately upon its detonation, a quantity of water is formed, which ftreams down upon the earth.

The inflammation of this gas by the electric fpark, is one of the moft remarkable phænomena in nature, and one of thofe of which the origin is leaft known. We are equally at a lofs to explain, how the electric fpark comes to be capable of fixing a mixture of vital air and azotic gas into nitric acid.

XII. Sulphurated hydrogenous gas, or *hepatic gas*, has been very well diftinguifhed from other hepatic gafes by Bergman. It is obtained from folid alkaline fulphures, or *livers of fulphur*, by decompofing them with acids in a pneumato-chemical apparatus. This aeriform fluid has a very fœtid fmell: it kills animals: it renders fyrup of violets green: vital air precipitates fulphur from it: it is kindled by the electric fpark, and by the contact of burning bodies: it burns with a reddifh blue flame; and, as it burns, depofites fulphur on the fides of the veffels containing it: the ruddy nitrous acid, the fulphureous acid, and the oxigenated muriatic acid decompofe it, deftroy its elaftic fluidity, and feparate the fulphur. It combines with water, and the folution is decompofed by the action of air: fulphurated hydrogenous gas colours and reduces oxides of lead, bifmuth, &c.; it precipitates folutions of metals. Some metals, particularly mercury and

<div align="right">filver,</div>

filver, feparate the fulphur; accordingly, when paffed through glaffes containing mercury, a great part of it is decompofed.

All thefe phænomena agree in fhewing, that this gas contains fulphur in a very attenuated ftate. M. Gengembre, by an analyfis, has difcovered it to confift of hydrogenous gas and fulphur: to the folution or fufpenfion of fulphur, it owes its diftinguifhing characteriftics. The fulphur, however much attenuated, does not burn at the fame time with the hydrogenous gas, but is in part depofited during the combuftion of the gas: The caufe of this phænomenon is, that hydrogenous gas does not need combuftion of fo high a temperature as fulphur.

It is fulphurated hydrogenous gas which mineralifes fulphureous waters. On this account, the common acids never precipitate fulphur from thofe waters; but the nitrous acid, the fulphureous acid, and the oxigenated muriatic acid, in which the oxigene is not very intimately combined with the acidifiable bafe, feparate the fulphur by abforbing the hydrogene. If too much of any of thefe acids be employed, efpecially of the oxigenated muriatic acid, the fulphur of this gas will be burned, and converted into fulphuric acid; and then no precipitate will appear.

Our acquaintance with fulphurated hydrogenous gas enables us to explain feveral things concerning fulphur, which we were before unable to account for: 1. We know now, why folid fulphures, recently prepared, are without fmell; and what occafions their becoming fo ftrongly fœtid, when moiftened: 2. It appears that water, though not decompofable by fulphur alone, is eafily decompofed by the joint action of fulphur and alkaline matters: 3. We underftand fully, how alkaline fulphures come to be decompofed by the air, and by feveral

veral metallic oxides, efpecially by the oxides of metals which do not decompofe water : 4. The theory of ful-phureous mineral waters is now eafy to explain ; as well as the hiftory of their decompofition by air and metallic oxides ; and the difficulties which were formerly found in all attempts to detect the fulphur by fimple acids, while it was not fufpected to exift in thofe waters in any other ftate but fulphure or *hepar.*

XIII. *Phofphorated hydrogenous gas* was difcovered by M. Gengembre, who called it, at the firft, *phofphoric gas.* He obtained it, by boiling a lixivium of cauftic potafh with half its weight of phofphorus, and receiving the elaftic fluid that was difengaged, into glaffes containing mercury. It kindles by the mere contact of air, pro-ducing, as it takes fire, a faint explofion. The folid phofphoric acid which it affords, forms, when burning, a fort of *corona* in the air, when not agitated ; and, to-wards its extremity, the diameter of the flame does not diminifh, but is enlarged. When mixed with vital air under glaffes, it burns with the greateft rapidity, and produces fuch heat and dilatation that the glaffes burft if they be not very thick, or if the proportions of the mixture be too large. M. Gengembre has fhown, that this new gas is a folution of phofphorus and hydrogenous gas. It bears a confiderable refemblance to fulphurated hydrogenous gas ; and differs from it in nothing but the nature of the combuftible body fufpended in the hydro-genous gas. As phofphorus is much more combuftible than fulphur, phofphoric hydrogenous gas kindles in the air : the phofphorus is firft kindled, and communicates the inflammation to the hydrogenous gas, which is heated by its combuftion. In fulphurated hydrogenous gas, on the contrary, the hydrogenous gas is kindled only by the

contact

contact of fome burning body; and the fulphur not being fufficiently heated, is feparated unburnt.

XIV. *Hydrogenous gas,* mixed with azotic gas, forms that elaftic fluid which M. Volta has denominated *inflammable air of marfhes.* It is produced by the putrefaction of fome vegetable matters, and of all animal fubftances. It is difengaged from waters in marfhes, ponds, houfes of office, and all places where there are animal matters putrefying in water. It either accompanies, precedes, or follows, the formation of ammoniac which takes place in putrefaction. I take it to be a fimple mixture, of which the component parts are not united by combination; for, were they actually combined, the refult would be ammoniac: but it differs from ammoniac, 1. In the elaftic ftate of the two fluids of which it confifts; 2. In the proportions of thofe elaftic fluids, which vary in this mixed acid, but in ammoniac are always the fame. We are indebted for our prefent accurate knowledge of this gas to M. Berthollet. In the years 1778 and 1779, I examined the inflammable gas of marfhes, and difcovered it to contain carbonic acid: but in feveral of thofe gafes, found in different parts of the neighbourhood of Paris, I found a mixture, the nature of which I did not properly diftinguifh; although I afferted, as may be feen in the 164th page of the collection of my Memoirs in 8vo, that it is fometimes accompanied, or even has its place fupplied, by *phlogifticated gas,* which, as I have elfewhere fhewn, is the fame with what we at prefent call azotic gas. Thefe were merely vague affertions at the time when I inferted them in my Memoirs: but M. Berthollet has fince communicated to them a degree of certainty and precifion which

induces

induces me to diftinguifh this gas by the peculiar names above given to it.

Hydrogenous gas, mixed with azotic gas, burns with a blue flame. It detonizes, but not eafily, with vital air. When caufed to detonize, in M. Volta's eudiometer, it is found to produce fome drops of water, and a refidue more or lefs pure.

XV. I diftinguifh, by the title of *hydrogenous gas* mixed with carbonic acid, that gas which is obtained by diftillation from many vegetable matters, particularly from tartar, and all tartareous falts; from acetous falts; from hard wood; from charcoal burning with the help of water; from mineral coal, &c.

It does not burn very readily; but it is not abfolutely incombuftible, even though three fourths of its bulk be carbonic acid. This acid is feparated from it, and the hydrogenous gas purified by lime-water and cauftic alkalis. It is a fimple mixture, without combination. Hydrogenous gas is not capable of decompofing carbonic acid; for coal decompofes water, having a ftronger affinity than hydrogene with its oxigene.

XVI. *Laftly,* It is now known that coal, though very much fixed in clofe veffels, and in our common fires, is liable to be reduced to vapour, and diffolved into elaftic fluids, in a very high temperature. Hydrogenous gas acts with more energy than any other fubftance in diffolving carbone, and maintaining it in fufpenfion; it frequently therefore carries it with it, as it affumes an elaftic fluid form. It is this mixed gas that is difengaged, when caft iron and fteel are diffolved in fulphureous acid diluted in water. In confequence of the former having abforbed carbonaceous matter in the tops of the furnaces, and the

latter

latter in its cementation, it even appears that coal may be directly diffolved in hydrogenous gas, by directing the rays of the fun from the focus of a mirror, through the middle of a glafs filled with this gas, upon coal placed on mercury in the bottom of the glafs. This fluid burns with a blue flame; and gives out, during its combuftion, fmall white or reddifh fparks. The exiftence of coal in folution in this gas, appears from its gravity, and from its combuftion in vital air, which produces carbonic acid. It likewife appears, that coal communicates to hydrogenous gas its well-known foetid fmell, or at leaft it renders that fmell ftronger. Laftly, coal modifies the effects of this gas, and changes the refults of its combinations. Thus, a mixed gas, formed by the folution of coal in azotic gas, feems to be the colouring matter of Pruffian blue. But we are not yet acquainted with all the compounds into which coal enters: and the fame is to be faid of the various mixtures of all the gafes with one another, which certainly take place in a great many inftances, but of which chemiftry has not yet eftimated the effects.

Of the Application of the Facts which have been collected, concerning the Nature and Properties of Elaftic Fluids, to the great Chemical Phænomena produced by Nature and Art.

IT is now acknowledged as an unqueftionable fact, that there is perhaps not a fingle phænomenon in chemiftry in which fome elaftic fluid is not either difengaged or fixed; nay, fometimes both the difengagement and fixation of elaftic fluids take place on the fame occafion: and the difcoveries of the moderns have proved, that the manner in which fuch phænomena were formerly ac-

counted for, neither explained the caufes, nor gave a juft view of the effects. The perfpicuity which thefe difcoveries have introduced into this part of the fcience, is a fufficient proof of their importance.

On comparing the numerous facts which conftitute the prefent fyftem of chemical knowledge, it appears that they may be reduced to a few general claffes, containing them all under diftinct heads. Such an arrangement is the more neceffary, as it fhows the connections and mutual relations of thofe facts; and muft form, of confequence, the elements of the fcience of chemiftry. But this, laft object cannot be attained, till all the general phænomena be explained : and as we are ftill unable to account for a number of thefe, as I am about to fhow, this method of laying down the elements of chemiftry is to be confidered in no other light than as a propofal, the importance and utility of which render it worthy the attention of philofophers.

It is with a view to contribute in part to the carrying of this project into execution, or at leaft to fhow that it is not impoffible, that I have attempted to reduce all the facts, and the whole theory of chemiftry, under fourteen leading phænomena, comprehending the various changes which natural bodies are liable to fuffer from the action of the chemical affinities. In order to proceed regularly from fimple to compound, in explaining thefe phænomena, I arrange them in the following order :

1. The production or difengagement of heat, and its abforption, with the effects of both.

2. The influence of air on combuftion.

3. The effects produced by light on bodies.

4. The decompofition and the recompofition of water.

5. The production and the decompofition of earths.

6. The formation and the decompofition of alkalis.

7. The

7. The formation and the decompofition of acids.

8. The combination of acids with earths and alkalis.

9. The oxidation and the reduction of metals.

10. The folution of metals by acids.

11. The formation of the immediate principles of ve- getables by vegetation.

12. The feveral forts of fermentation.

13. The formation of animal matters by the life of animals.

14. The decompofition and putrefaction of animal matters.

Let us briefly confider each of thefe phænomena, and explain their effential relation to the properties of elaftic fluids.

I. *The production of heat* is owing either to the force of preffure, which difengages it in bodies in which it is contained,—or to combination, which difengages it in like manner. It is to be obferved, that this phænomenon takes place more efpecially when an elaftic fluid is fixed in any body; becaufe, as we have already feen, the aeri- form ftate of any fubftance fuppofes the prefence of a good deal of combined heat. It is alfo to be obferved, that as every different body contains a different quantity of heat, or, in other words, different bodies have differ- ent capacities of heat,—therefore preffure or combination muft produce, from different bodies, very different quan- tities of this fubftance. For which reafon, this phæno- menon, which accompanies a great part of the operations of chemiftry, fhould be obferved and eftimated with the utmoft care, in experiments in which accuracy is intend- ed. Similar to this, is the manner in which the appa- rent deftruction or *abforption of heat* takes place, which is likewife very often obferved in chemical proceffes. It always depends on the increafe of the bulk of bodies,

and on their then acquiring a greater capacity for the re‑ ception of the matter of heat.   Both of thefe phænome‑ na, therefore, may be eftimated mechanically, or merely by obferving how the particles of bodies are com‑ preffed together, or removed from each other.   But in order to form a more juft idea of it, we muft add to this mechanical caufe, the confideration of the particular chemical attraction or affinity between heat and the body on which we are obferving its operation.

II. Combuftion is one of the moft important phæno‑ mena in nature.   We may diftinguifh two diftinct claf‑ fes of combuftions,—thofe which take place in the air, and thofe which take place apparently without the con‑ tact of vital air, but on fubftances containing its bafe.

Combuftions effected by the contact of air, are, as has been already faid, combinations of the combuftible body with the bafe of vital air or oxigene.   In proportion as thefe combinations take place, the matter of light and ca‑ loric are feparated from the oxigene, and appear in the fen‑ fible form of heat and light.   There are fome combuftible bodies which difengage thefe fluids flowly from vital air, and afford only heat when they burn : others, again, difengage thefe principles rapidly, and caufe them to ap‑ pear in the form of fparkling light, and glowing heat. By communicating more or lefs ofcillation to this light, they give it different fhades of colouring; if, with Euler, we confider different coloured rays of light as being all the fame matter, only actuated by different ofcillations, fimilar to the vibrations of found.   In certain com‑ buftions effected by air, the combuftible bodies have fo great an affinity to the bafe of the elaftic fluid, that they attract it with the utmoft facility; others require, in order to their combination with oxigene, a temperature fometimes exceedingly high, which appears

to

to promote the attractive influence of the combuftible body on that bafe. This theory accounts for the increafe of the weight of a burnt body; the change of its ftate; the impurity of atmofpheric air after combuftion,—for the proportion of azotic gas then becomes much larger,—and the diverfity of the phænomena, fuch as flame, heat, and 'rarefaction, which accompany every fpecies of combuftion which is effected in the atmofphere.

The fecond clafs of combuftions is generally effected in clofe veffels. It confifts in general in the tranfition of oxigene, either more or lefs folid, out of a body already burnt, into an unburnt body. It depends upon the different elective attractions of this principle for different combuftible bafes. To this clafs belong, the oxidation of metals by acids,—the reduction of metallic oxides by coal,—the combuftion of fulphur, phofphorus, coal, and carbure of iron by nitric acid,—the combuftion of hydrogene, the principle of ammoniac, by the oxigenated muriatic acid, &c. &c. In all thefe inftances, oxigene paffes out of one body into another; and as it was not melted by heat and light, thefe combuftions generally take place without flame. We may obferve, that in thefe inftances of combuftion, which may be called *tacit*, the property of combuftibility is not loft, but only transferred from the body which abforbs the oxigene to that which lofes it. We may likewife add, that as oxigene is more or lefs folid, that is, more or lefs deftitute of heat and light in the compounds into which it enters, bodies which detach it may fometimes abforb it in a more pure and folid ftate than it was contained in thofe in which it before exifted: and the difengagement of heat, and even of light, muft then take place. Such is the origin of thefe two phænemona in detonations by

nitre,

nitre,—in the apparent action of nitric acid on fulphur, coal, phofphorus, the generality of metals, oils, and alcohol.

III. *The effects of light on bodies*, have not been hitherto eftimated any other way than by their confequences; their caufe has never yet been properly explained. It has been long known to act upon vegetables, to communicate to them colour, and to develope their combuftible principles. Scheele obferved, that the rays of the fun coloured nitric acid, muriate of filver, mercurial precipitates, &c. It is at prefent well known, that all thefe effects are attended with the difengagement of a more or lefs confiderable quantity of vital air : light, therefore, acts at the fame time with heat upon thefe bodies,—feparates their oxigene, melts it, and caufes it to pafs into the ftate of elaftic fluidity. It is in this manner that it contributes to the decompofition of carbonic acid by the leaves of vegetables. That decompofition is, in truth, owing to a double attraction ; 1. The attraction of light and heat for oxigene, which they tend to difengage into vital air, &c. ; 2. That with which vegetable matters act upon carbone, the radical principle of this acid. By the fame mechanifm, light promotes the decompofition of water by the fame organs of vegetables, and contributes to the formation of their oleaginous principle. By attending with more care than has been hitherto done, to the action of light upon many natural bodies, fome important difcoveries may be made, as I pointed out in the year 1780.

IV. *The formation and the decompofition of water*, depend entirely on the affinities of oxigene, which is one of its principles. Zinc, iron, oils, and coal, are already
known

known to poffefs the property of feparating the princi-
ples of water, by abforbing its oxigene, and difengaging
its other principle, hydrogene, in the form of hydroge-
nous or inflammable gas. The extreme levity of this
gas, accounts for the high temperature requifite to effect
this decompofition fuddenly. It appears, that the bafe
of this gas, hydrogene, which is commonly either liquid
or folid, in the two ftates in which water is commonly
found on the furface of the globe, has a very great ca-
pacity for containing the matter of heat. It even ap-
pears, that this bafe, though combined with oxigene
and water, ftill poffeffes this property of abforbing a
great deal of heat; and that it is this property which
renders aqueous vapour lighter than air; in confequence
of which, the mercury finks in the barometer, when the
atmofphere is filled with that vapour. This noble dif-
covery of the nature and the decompofition of water,
throws much light on the theories of metallic folutions,
—of the oxidation of various metals by moifture,—of
the formation of the immediate principles of vegetables,
—of fpiritous fermentation, and of putrefaction: And
we already fee, that almoft all chemical theories are re-
ferable to, and depend upon the affinities of oxigene.
It throws alfo great light on the phænomena of the at-
mofphere,—the formation of meteors,—the laws which
nature obferves in the fucceffive changes of organic
matters, &c.

V. There are ftill feveral important *defiderata* with
refpect to the formation of bodies, which the labours of
chemifts have not explained. One of thefe is the *forma-
tion of earths*. Naturalifts have given their opinions
concerning the formation of earths: feveral of them
have confidered the converfion of filex into clay, as a
fact fufficiently proved; but that notion is nothing but

an

an ingenious hypothefis, not fupported by facts. Che-
mifts have not been able to change either filiceous earth
into alumina, or alumina into filiceous earth. Nature,
perhaps, operates this converfion ; but as we are unac-
quainted with the means which fhe employs, we fhould
not venture to guefs, when not countenanced by direct
experiments. To confider barytes, magnefia, and lime,
as compounds confifting of filiceous and aluminous earths
united with fome other bodies, is to advance hypothefes
which deferve but very little credit. No chemift has
hitherto directed his enquiries to this fcope : the necef-
fary *data* are even wanting.

VI. Nearly fimilar is the ftate of our knowledge with
refpect to the formation of fixed alkalis. The modern
ideas of the principles of chemiftry, lead us to fufpect azote
as a principle of thefe falts.—We may perhaps even ven-
ture to confider this body, the exiftence of which in
ammoniac has been fully proved by M. Berthollet, as
a principle common to fixed alkalis and alkaline earths
in general,—in a word, as the *alkaligenous* principle.
For inftance, there can be no doubt, that the fixed al-
kalis are partly decompofed in many of the operations of
Chemiftry : in the diftillation of old foaps, and tartareous
and acetous neutral falts, they are plainly changed into
ammoniac.—This tranfmutation feems to fhew, that fixed
alkalis contain azote, which, by attaching itfelf to the
hydrogene of the oil, forms ammoniac.—But thefe facts
have not yet been carefully examined, with refpect to
the quantities of the fixed alkalis which appear to be de-
compofed, and that of the ammoniac which is obtained,—
nor, what is of no lefs importance, with refpect to the
refidue produced from the fixed alkalis ; and we cannot
hope to eftablifh our theory upon this fact, till its cir-
cumftances

cumſtances be more exactly known. But though theſe were known, we ſhould ſtill have to enquire into the nature of the other principle or principles of fixed alkalis, and in what manner the radical principle of potaſh differs from that of ſoda, &c.

VII. *The formation and the decompoſition of acids*, is one of the moſt valuable and beſt known parts of modern chemiſtry. We know that they conſiſt all of a baſe or radical principle, more or leſs combuſtible in combination with oxigene : that the oxigene being the ſame in them all, is the principle of their acidity ; and that the differences among them are owing to the ſubſtances combined with the oxigene ; which differ in each different acid.—We know the baſes of the ſulphuric, the nitric, the carbonic, the arſenic, and the phoſphoric acids ; we know them to be ſulphur, azote, coal, arſenic, and phoſphorus. But the acidifiable baſes of the muriatic, the fluoric, and the boracic acids in the mineral kingdom, remain ſtill to be diſcovered ; as well as the proportions in which hydrogene and carbone, which ſeem to form the baſes of all the vegetable acids, are united in them.

The decompoſition of the acids whoſe nature is known, is not hard to explain. We know that it muſt happen, whenever a combuſtible body, having a ſtronger affinity with oxigene than oxigene has with the acidifiable baſe, is applied to any acid : And ſuch is the theory of ſulphureous and nitrous acid gaſes by the decompoſition of the ſulphuric and nitric acids, &c.

VIII. *The combination of acids with earths and alkalis*, forms the hiſtory of neutral ſalts, and of the mutual affinities or elective attractions of thoſe different matters.

It

It comprehends the examination of the phænomena which take place when they unite,—the tafte which they acquire,—their form, folution, cryftallization, alterations by fire and air, and mutual decompofitions. It has been treated of at great length in this work.

IX. The oxidation and reduction of metals is alfo referable to the hiftory of air and oxigene. We know, that what has been called the *calcination* of metals, is a combuftion,—that it confifts in the union and fixation of the bafe of vital air or oxigene in the metal calcined;—that metallic *calces* are compounds of metals and oxigene, which we call *oxides*;—that moft oxides are reduced only by giving out their oxigene to fome other body having a ftronger affinity with it;—that coal, by abforbing oxigene from metallic oxides in this manner, forms with it the carbonic acid, which is difengaged in fuch abundance during their reduction;—and that there are fome metallic oxides, from which oxigene is feparated in the ftate of vital air, by means of heat and light,—a fact which proves, that this oxigene is combined with different metals, with very different degrees of adhefive force. But two very important particulars in the hiftory of the oxidation of metals, which have been afcertained by modern experiments, and which throw great light on all the phænomena of metallic matters, are, 1. That every different metal abforbs, in order to its faturation, a different quantity of oxigene: 2. That each metal may exift in different ftates of oxidation,—or, combined with different proportions of oxigene,—from that which merely begins the oxidation of a metal to that by which it is completely accomplifhed,—for inftance, from fifteen to forty, or more parts of oxigene, to the hundred weight of iron.

The

The attentive examination of this fecond fact, leads us to diftinguifh, in every metallic oxide, feveral different ftates in refpect to the quantity of oxigene which it contains. Thus, mercury fuffers an incipient oxidation, and is changed into a black powder in a number of circumftances, which have been hitherto confidered as effecting only an extreme attenuation of the metal : Thus, iron, in the ftate of martial ethiops, is the firft oxide of that metal, in refpect of the fmall quantity of oxigene which it contains, and cold water eafily reduces the metal into this ftate : Laftly, copper, beginning to be oxidated, or combined with the fmalleft poffible quantity of oxigene, is brown and reddifh ; whereas an oxide of this metal, fully faturated with oxigene, is of a bright green.

This diftinction of metallic oxides, according to their different ftates of oxidation, or according as they contain different quantities of oxigene, and poffefs different properties, in confequence of their having been more or lefs burnt, enables us to explain a great many phænomena, of which chemifts were formerly able to give no fatisfactory account.

X. *The folution of metals* in different acids, the properties of thefe folutions, and of the falts which they afford, agree very well with the modern theory, and are much better explained by it than they formerly were. No folution of a metal in an acid can take place, without the metal's being firft oxidated.

Metals are oxidated by the fulphuric acid,—either by the acid itfelf, or by the water in which it is diluted. In the firft of thefe cafes, the acid is decompofed, and a quantity of fulphureous acid gas difengaged ; in the fecond, the water is decompofed, and hydrogenous gas difengaged.

engaged. Some metals decompofe only the fulphuric acid, without acting upon the water; fuch as mercury, lead, &c.; and to burn thefe metals, the acid muft be concentrated. Metals which act with more energy in decompofing water than in decompofing fulphuric acid, fuch as zinc and iron, are not fo readily oxidated unlefs the acid be diluted, as it is from the water they muft derive the neceffary oxigene. What proves the certainty of this laft fact, is, that the fulphuric acid remains undiminifhed, none of it being decompofed. From thefe circumftances it is clear, that much more fulphuric acid muft be neceffary for the folution of a metal which decompofes the acid, than for the folution of a metal which decompofes the water combined with it. In the former cafe, two different fums of the acid are requifite, one to oxidate the metal, and another to diffolve the metallic oxide: if only the firft fum were mixed with the metal, it would only be oxidated, and the fecond fum of acid would ftill be neceffary to diffolve the oxide: in the laboratories, there is frequently occafion to make fuch an addition. Accurate obfervation has fhown, that metallic oxides ought to be always in the fame degree of oxidation or combination with oxigene, in order that they may be diffolved in the fulphuric acid; and that when they are fully faturated with the acid, they no longer combine with it. Before this period, they are not foluble in it; beyond it, they are precipitated,—an event which happens when a fulphuric folution is expofed to too ftrong a heat, or left for a longer or fhorter time expofed to the air. In the firft of thefe operations, the heat promotes the action of the metallic oxide upon the acid; and it of confequence takes up more oxigene than it contained or needed in order to remain fufpended in the acid; in the fecond inftance, it abforbs that principle

ciple

ciple from the atmosphere, till, acquiring more than is neceffary to its fufpenfion, the oxide is precipitated. Such is the theory of fulphuric mother waters. Solutions of metals by this acid afford cryftals only in the former cafe. All thefe facts agree in fhewing, that the metals act firft upon their folvents ; and that the fulphuric acid does not act upon them till they be oxidated to a certain degree.

Nitric acid is likewife decompofed by moft metals. They are oxidated or *calcined* to a certain degree by abforbing its oxigene, with which they have a greater affinity than azote. But they not taking up all the oxigene of the nitric acid,—not, at leaft, unlefs too much of the metal be employed, and the mixture be too much heated,— the azote is feparated in combination with a portion of oxigene; and this particular combination conftitutes nitrous gas. The nitric acid is more liable to decompofition than any other acid ; its two component principles not being very intimately united. For this reafon, it has always been confidered as the chief folvent; and it is owing to the fame circumftance, that water is feldom decompofed during the mutual action of metals and the nitric acid, and that a large quantity of water puts a ftop to this re-action. Accordingly, folutions of metals in the nitric acid afford only one fort of elaftic fluid, nitrous gas, which is fometimes mixed with a little azotic gas, efpecially if the metals employed have a very ftrong affinity with oxigene, and abforb a great deal of it.

Metals which are foluble in the nitric acid combine, and remain in combination with it, only when containing a certain quantity of oxigene not equal to their faturaration. Many metallic oxides, therefore, fuch as thofe of bifmuth, antimony, mercury, tin, and iron, are very eafily feparated from nitric acid, folely by reft, by heat,

or

or by expofure to the air. As they continue to abforb oxigene from the acid in which they are diffolved, or from the furrounding atmofphere, the quantity of nitric acid muft alfo be very large; that it may be fufficient, firft, to oxidate the metal,—fecondly, to diffolve the oxide. If you employ only what is requifite for the former purpofe, you obtain only a dry oxide; as in the inftances of bifmuth, zinc, tin, and antimony.

The muriatic acid does not act upon any metal without the affiftance of water. Wherefore, as there are but few metals which act upon water, there are but few directly foluble in muriatic acid; and nothing but hydrogenous gas is ever difengaged, in the cafe of folution, by this acid. Every thing concurs to fhow, that the principles of this acid adhere more obftinately together than thofe of any other acid; and from this I am much inclined to think, that the unknown bafe of the muriatic acid, whatever it be, is the body which has the greateft poffible affinity with oxigene. None of the combuftible bodies which detach that principle from the other fubftances that contain it, takes it from this acid : but when metallic oxides are once formed, it diffolves them very readily; it even detaches them from feveral other acids; and it diffolves them even when fully faturated with oxigene, which the other acids are not capable to do. The two laft of thefe properties, which are very remarkable, certainly depend on the tendency which the muriatic acid has to abforb an excefs of oxigene; a tendency fo fully proved by the formation of the oxigenated muriatic acid, &c.

The action of the other acids on metals is not yet fufficiently known, to enable us to explain it fo accurately. We fhall only remark, that metals cannot decompofe the carbonic acid; for coal, the radical principle of that acid,

acid, has a ftronger affinity with oxigene than oxigene has with metals ; as is proved by the decompofition of metallic oxides by the carbonaceous principle.

Laftly, The precipitation of metallic oxides from acids, by other metallic fubftances, depends entirely on the diverfity of the affinities of oxigene with thefe fubftances. When copper precipitates oxide of filver, and iron oxide of copper, in filver and copper ; the reafon of thefe phænomena is, that copper has a ftronger affinity with oxigene than filver, and iron than copper.

XI. We are only beginning to underftand the formation of the immediate principles of vegetables. It was long ago obferved, that plants grew very well in pure water ; and that all their conftituent principles were formed with water and atmofpheric air : From thefe two fources they derive all their nourifhment : From thefe, their extract, mucilage, oil, coal, acids, colouring parts, &c., are produced. Since the difcovery of the different gafes, it has been obferved, that they grow very rapidly in air altered and mixed with carbonic acid, as well as in hydrogenous gas. We have already taken notice, that leaves decompofe water and carbonic acid. From the former, they abforb hydrogene ; and from the fecond, carbone ; difengaging, from both, vital air. They appear, likewife, to abforb azote. Thefe wellknown phænomena explain the formation of coal and of oil : for there can be no doubt, that the latter of thefe principles confifts of fixed hydrogene, if the expreffion may be ufed, as it affords a good deal of water during its combuftion. But we are ftill ignorant of the manner in which the colouring principle, the aroma, the fixed alkali, and the glutinous part, are formed ; and whence the varieties of the oils, &c.; only we may venture to

foretel,

foretel, that new experiments on vegetation, in profecution of thefe new views, will hereafter explain the nature and the compofition of all thefe different immediate principles.

We are now beginning to underftand the formation of vegetable acids, during vegetation, and even by that act. In the hiftory of acids, we have already taken notice, that they appear to be all formed of fimilar bafes : that, by a laft analyfis, we obtain equally from them all, carbone, hydrogene, and oxigene ; and that they feem to differ only in the proportions of the principles, and in the preffure or denfity of the fubftances. The more we extend our experiments upon acids, the more probable will this opinion appear.

Scheele and M. Crell have found an analogy to exift among feveral of them. Scheele, who at firft thought the oxalic acid and the acid of fugar to be different from each other, was at length convinced, as we have mentioned elfewhere, that there is no difference between thefe acids, but that they are precifely the fame ;—1. By extracting the portion of potafh which conceals the properties of the oxalic acid in common falt of forrel, and, by that means, reducing it to pure oxalic acid ; 2. By changing acid of fugar into falt of forrel, by the addition of a little potafh.

If to this moft important fact in the analyfis of vegetables, we add the valuable experiments of M. Crell, who has extracted tartareous acid from alcohol, and has changed tartareous acid into vinegar, and into oxalic acid, and oxalic acid, again, into acetous acid,—we fhall fee, that the oxalic, the tartareous, and the acetous acids, greatly refemble each other : that they are formed from one bafe, and differ only in the proportions of the oxigene which they contain. It appears that the tartareous

reous acid contains leaft of this principle: that the oxalic acid contains a good deal more of it; and that the acetous acid contains ftill more than either of the other two. I cannot help thinking, that if four vegetable a-cids, which were at firft thought to be effentially differ-ent from each other, have been already found to confift of the fame bafe, combined with different proportions of oxigene; future experiments may in like manner difco-ver the fame analogy to fubfift among others, particular-ly between the citric and the malic acids, which are fo often found together in vegetable juices.

XII. Spiritous fermentation,—the fimultaneous forma-tion of the carbonic acid and alcohol,—the neceffity of water and a faccharine principle to begin that fermen-tation,—all together afford us reafon to think, that it is produced by the decompofition of water. The oxigene of the water combining with the coal, forms carbonic acid, which is difengaged; and the alcohol is formed by the fix-ation of the hydrogene in the oily bafe, which, with different quantities of oxigene, forms the tartareous, the oxalic, and the acetous acids. This theory explains fully the reafon why alcohol affords fo much water in combuftion,—why it is changed by mineral acids into oxalic acid, acetous acid, &c. It is true, we do not yet well underftand how it paffes into the ftate of æther; only it is probable, that in fuch operations, the alcohol lofes a portion of its oxi-gene, which goes to the formation of water.

XIII. Chemifts are beginning to conjecture, how far the fcience can conduct them in their enquiries into the formation of animal matters. Digeftion feems to be fim-ply an extraction or folution by the gaftric juice. The fix-ation of azotic gas is one of the principal functions of or-

ganization.   From the experiments of Scheele, and, ftill
more, from thofe of M. Berthollet, it appears to occafion
the principal difference between animal matters and ve-
getable fubftances.   It contributes to the formation of
the ammoniac which thefe fubftances afford in fuch a-
bundance by diftillation, &c.   We know not yet in
what manner azotic gas is fixed in animals, whether by
the ftomach or by the fkin, &c.   The differences a-
mong the animal fluids defigned for the nourifhment of
the different organs, and the peculiar nature of the gela-
tinous humour, of the albuminous liquor, and of the fi-
brous part, which is melted and diffolved in certain
fluids, are now fufficiently afcertained.   We know that
the former is the leaft animalifed,—that the fecond is
more fo,—and that the third is the laft fubftance pro-
duced by the action of the vital functions upon the fluids :
We know, alfo, that this laft humour is reunited fimply
by reft into a tiffue of folid fibres ; and that the albu-
minous part is thickened, and rendered concrete by
heat ; whereas the gelatinous fubftance is fooner de-
compofed, but alfo more readily reproduced.   Peculiar
acids have been found in the excrementitious humours,
but we know nothing of their formation : we are par-
ticularly ignorant of the manner in which the phofphoric
acid, which abounds fo generally through this kingdom,
is formed.

The nature of the folids of animals has engaged the
attention of modern chemifts.   The diftinctive nature
of the fibrous texture of the mufcles,—of the membra-
nous plates,—of the hard laminæ of the bones, &c., is
now known.   Medicine expects, from the difcoveries of
chemiftry, a folution of the problems which ftill fubfift
concerning the formation of the feveral matters which
conftitute thefe parts ; efpecially of the phofphoric acid,
                                                    the

the albuminous juice, the fibrous matter, calcareous phofphate, and the peculiar oils which are found in this kingdom of nature. The formation of ammoniac, which was gueffed at by Bergman and Scheele, and has been fince fully explained by M. Berthollet, affords us reafon for thinking, that all thefe problems may be fucceffively folved. In all probability, we want only a few principal facts, to enable us to reach feveral important refults: The hope of this muft encourage thofe phyficians who know the importance of chemiftry.

XIV. Ever fince the days of Chancellor Bacon, the hiftory of putrefaction has been acknowledged as an important object in medical enquiries. Several eminent naturalifts have ftudied it with fome fuccefs: But the caufe of this decompofition, and the manner in which it is effected, have not been yet difcovered. The late difcoveries throw fome light on this important point. Water, which promotes and excites putrefaction, is underftood to be decompofed in that inteftine emotion. We underftand how ammoniac is formed in fuch abundance, —by the fixation of azotic gas and hydrogenous gas. The flow decompofition of greafe, its prefervation and condenfation, which in fome inftances proceeds to folidity and hardnefs in confequence of the fixation of vital air from water, are now accounted for: In like manner have been explained, the volatilization and reduction of dead animal fubftances expofed to the air, into elaftic fluids; in a word, the complete feparation of all thofe principles, and their difperfion in the atmofphere, which conveys them into new combinations; with that whole feries of compofitions, and tranfitions of fubftances out of one kingdom into another,—fo happily expreffed by Beccher under the philofophical emblem, *circulus eterni motus*, which he ufes to fignify the indefatigable activity of nature.

EXPLANATION

OF THE

TABLE OF THE NOMENCLATURE.

WE shall begin with observing, that it was not our intention to exhibit, in this Table, the whole of the chemical nomenclature : Our design was only to arrange together, under several classes of compounds, such a number of select examples as might enable any person, with a little study, to apply the principles of our system of nomenclature to all the compounds with which chemists are at present acquainted, as well as to those which may be hereafter discovered. For this purpose, we have divided the table into six perpendicular columns, with the general titles at their heads, expressing the state of the bodies whose names they contain. Each of these columns consists of 55 divisions, —that being the number of the undecomposed substances with which we are acquainted, and which succeed in order in the first column. The correspondent horizontal divisions of the other five columns, comprehend the principal combinations of those simple substances, and must of consequence be equally numerous.

We shall trace each of these columns through its principal divisions.

<div align="right">COLUMN</div>

Column I.

The title of the firſt column is, SUBSTANCES THAT HAVE NOT YET BEEN DECOMPOSED. The reaſon why we conſider theſe bodies as ſimple, is, that we have not yet been able to analyſe them. All the accurate experiments which have been performed during theſe laſt ten years, concur to ſhew, that theſe bodies can neither be ſeparated into more ſimple ſubſtances, nor reproduced by artificial combinations. Theſe ſubſtances are, as we have already mentioned, 55 in number. They, with their correſponding compounds are numbered with Arabic numerals, running down both the right and the left ſides of the table.

The 55 ſimple ſubſtances of the firſt column are divided into five claſſes, according to the differences of their nature. The firſt of theſe claſſes conſiſts of four bodies, which appear to come nearly under the character that has been aſſigned to the elements, and act the moſt important part in combinations. Theſe are, 1. *Light*; 2. *Caloric*, which has hitherto been named matter of heat: 3. *Oxigene*, or that part of vital air which becomes fixed in burning bodies, increaſes their weight, and changes their nature, and of which the moſt eminent property being to conſtitute acids, has induced us to give it a name alluding to that remarkable characteriſtic: 4. *Hydrogene*, or the baſe of the elaſtic fluid which is called Inflammable Gas, and which, as it is one of the principles of water, exiſts in ice in a ſolid ſtate. Theſe firſt four principal bodies are connected by a brace.

The ſecond claſs of the undecompoſed ſubſtances in the firſt column, conſiſts of 26 different bodies,—all of which are liable to become acid, by combining with

oxigene;

oxigene; and in confequence of their poffeffing this characteriftic in common, we diftinguifh them by the name of *acidifiable bafes*. There are only four of thefe 26 bodies that can be obtained in a fimple uncombined ftate. Thefe four are, *azote*,—the *radical principle* of the nitric acid *, or the folid bafe of atmofpheric me-phitis, well known at prefent to chemifts, in the fifth divifion; *pure coal*, *carbonic*, or the *radical principle* of the carbonic acid, in the fixth divifion; *fulphur*, or the *radical principle* of the fulphuric acid, in the feventh divifion; and *phofphore*, or the *radical principle* of the phofphoric acid, in the eighth divifion. The other 22 are only known as they exift in combination with oxigene, and in the ftate. of acids. But in order to extend and fimplify the Science, we have fuppofed them feparated from oxigene, and exifting in that pure ftate to which it is probable they may one. day or other be reduced by art. They are all, therefore, inferted in the firft column, as exifting in this fuppofed fimple ftate, and dif-tinguifhed as the radical principles of the acids into which they enter.

The third clafs of the undecompofed fubftances of the firft column, confifts of metallic matters, in number 17, extending from the 31ft to the 47th divifion, *inclufivè*. They all retain the names by which they have been hi-therto known. The three firft are liable to pafs into an acid ftate,—agreeing, in this characteriftic, with the pre-ceding acidifiable bafes.

In the fourth clafs, are the earths which have not yet been decompofed,—*filiceous earth, aluminous earth, barotes,*

* It is alfo to be obferved, that azote is never obtained in a feparate infulated ftate, but always in a gazeous ftate, and in combination with caloric.

barotes, *lime*, and *magnesia*, in so many successive divisions. None of these five earths has yet been decomposed; and they are therefore to be considered, in the present state of our knowledge, as so many simple bodies.

Lastly, the fifth class of undecompofed substances, consists of the three alkalis,—*potash*, *soda*, and *ammoniac*. The last of these substances has been decompofed by Messrs Bergman and Scheele; and M. Berthoilet has determined, in a precise manner, the nature and the quantity of its principles: But we were unwilling to separate it from the fixed alkalis, the component principles of which we hope also to difcover in a short time: It would be improper to break through the order, and overlook the mutual relations of those substances, which in many respects act, in chemical experiments, as undecompofable matters.

The first column, all the divifions of which we have now explained, is, like each of the others, divided longitudinally into two; the left fide exhibits the old names of the substances in Italic characters.

Column II.

The fecond column is intituled, THE SAME SUBSTANCES REDUCED INTO THE STATE OF GAS, BY THE ADDITION OF CALORIC. It exhibits the permanent aeriform states into which a number of the fimple substances in the first column are liable to pass. In this column, there are only four elaftic fluids, the names of which, like all the words in the other columns, are derived from the names of the undecompofable matters, and are rendered fufficiently intelligible, by the addition of the word *gas* to the correfpondent words in the first

column:

column:—*Oxigenous gas, hydrogenous gas, azotic gas,* and *ammoniacal gas.*

COLUMN III.

The title of the third column informs the reader, that it confifts of THE SAME SUBSTANCES which appear in the firft column, COMBINED WITH OXIGENE. This is one of the fulleft columns in the Table; for, almoft all the bodies in the firft column are capable of combination with oxigene. The names in it are all compounded of two words, expreffive of the two matters of which the fubftances to which they belong confift. The firft of thefe words, is the generic term of the acid, which indicates the faline character that it derives from oxigene: The fecond peculiarifes each acid, and refers to its peculiar radical principle. The 5th divifion of this third column exhibits the combination of *azote,* or *nitric radical,* with oxigene. From that combination arife three compounds, produced by a diverfity in the proportions of the principles: The azote is either united with the leaft poffible quantity of oxigene, and it then forms the *bafe of nitrous gas;*—or faturated with it, and then it conftitutes *nitric acid;*—or united with lefs than in nitric acid, yet with more than in nitrous gas, and then it forms *nitrous acid.* We exprefs the three different ftates of this combination fimply by varying the termination of the fame word. In the fame manner, the termination of the *fulphuric acid* is varied in the 7th divifion; that of the *phofphoric acid,* in the 8th divifion; and that of the *acetic acid,* in the 13th. Thefe acids exift in two ftates of combination with oxigene, according to the quantities which their acidifiable bafes contain. When the bafes are
                                                        completely

completely faturated, the acids produced are, the *fulphu-ric*, the *acetic*, and the *phofphoric* : When the bafes are not faturated, and do not contain oxigene in a due pro-portion, we call the acids that are then formed, the *ful-phureous*, the *acetous*, and the *phofphorous*. We have followed the fame general rule in the denomination of all the other acids. When an acid is known only in one ftate, and, in that ftate, the bafe is fully faturated with oxigene, fuch as the carbonic or the boracic acid, its name then terminates in *ic :* when it is known in two ftates, it is diftinguifhed, in the ftronger ftate, by the termination *ic ;* in the weaker, or that in which there is an excefs of the acidifiable bafe, its name terminates in *ous.* Accordingly, in thofe acids which are known only in one ftate, and yet have their names terminating in *ous*, it may be underftood that there is an excefs of the acidifiable bafe : fuch are, the *tartareous* acid, in the 14th divifion ; the *pyro-tartareous*, in the 15th ; the *pyro-ligneous*, in the 21ft ; and the *pyro-mucous*, in the 22d. The *muriatic* acid, in the 9th divifion, is in a ftate different from any of the others. Befides its combina-tion, in which it is faturated with oxigene, it is alfo ca-pable of receiving an excefs of oxigene, which commu-nicates to it fome remarkable properties. To diftinguifh it as it exifts in this laft ftate, we call it the *oxigenated muriatic acid ;* and the epithet *oxigenated*, may be in like manner applied to any of the other acids that fhall be found exifting in the fame ftate. The lower divifions of this third column, from the 31ft to the 47th *inclufive*, exhibit the nomenclature of another fyftem of bodies. The word *oxide* is there found at the beginning of the compound denomination. The reafon which induced us to fubftitute this name to that of metallic calces, has been explained in our memoir on this nomenclature. It does

not

not exprefs a faline quality, as the word *acid* does, and yet denotes a combination of oxigene : and it may be applied to all bodies that are fufceptible of a combination with oxigene without paffing into a ftate of acidity ; and this, whether their not becoming acid be owing to the fcanty proportion of the oxigene, or to the nature of their bafes. Thus, for inftance, the phofphoric acid, vitrified, or deprived of a part of its oxigene, by the action of a ftrong heat, becomes a fort of *phofphoric oxide*. Nitrous gas, too, which is not more acid than phofphoric glafs, is properly a *nitrous oxide ;* and hydrogene, in combination with oxigene, forms not an acid, but water, which, in this light, may be confidered as an *oxide of hydrogene*.

Of the 17 metallic oxides, between the 31ft and the 18th divifion, there are 3 which are only in intermediate ftates between the metallic and the acid. It is for want of oxigene that the oxides of arfenic, molybdena, and tungften, in the 31ft, the 32d, and the 33d divifions, are not yet become acid. A greater quantity of the acidifying principle conftitutes them the *arfenic*, the *molybdic*, and the *tunftic* acids. Epithets taken from colour ferve to diftinguifh the different oxides of the fame metal, as may be obferved of the oxides of antimony, lead, and mercury.

Column IV.

The 4th column, intituled, The same substances in a gazeous oxigenated state, contains fimple fubftances combined both with oxigene and with a fufficient quantity of caloric to reduce them to permanent gafes, under the ufual preffure and temperature of the atmofphere. There are only fix fubftances known to exift in that ftate,—*nitrous gas, nitrous acid gas, carbonic acid gas, fulphureous gas, muriatic* and *oxigenated*
<div align="right">*muriatic*</div>

muriatic acid gas, and *fluoric acid gas.*—No other oxigenated fubftance having been reduced into a gazeous ftate by caloric, we have therefore introduced into this column fome peculiar combinations of metallic oxides, or oxigenated metals, with different bafes: It is accordingly divided in the middle; and the lower part intituled, METALLIC OXIDES WITH DIFFERENT BASES.— From the 3 1ft to the 45th divifion *inclufivè,* are the combinations of metallic oxides with fulphur and alkalis. The former are called *fulphurated oxides* of arfenic, lead, &c.; the latter, *alkaline metallic oxides.* When any of thefe compounds varies in the proportions, and confequently in its properties, we diftinguifh it in the fame manner as the fimple oxides, by epithets taken from colour: thus we fay, *grey, red, orange,* &c. *fulphurated oxides of antimony.*

COLUMN V.

The 5th column, confifting of the fimple SUBSTANCES in the 1ft column OXIGENATED AND NEUTRALISED BY THE ADDITION OF BASES, or, neutral falts in general, exhibits many more names than any of the preceding columns: and we have therefore found it neceffary to give, in this column, a greater number of examples, in order to fhow the fuperiority of this fyftem of nomenclature over the ancient names; moft of which, though expreffing fimilar combinations, were in nowife analogical.

Any perfon may fee, by looking flightly over this column, that the names contained in it, and expreffing fimilar combinations, have all one termination. It is eafy to fee, that this muft greatly facilitate the ftudy of the fcience, and contribute greatly to the perfpicuity of

works

works in chemiſtry in which this mode of denomination ſhall be adopted. The bodies belonging to this column are compounds of three ſubſtances,—acidifiable baſes, the acidifying principle, or oxigene, and terrene, metallic, or alkaline baſes. But we uſe only two words to expreſs their nature; for, the firſt of theſe being derived from the name of the oxigenous or acid combination, ſerves to denote that part of the body; the other refers ſolely to the baſe with which the acid is ſaturated. The names of all theſe compounds terminate in *ate*, when they contain acids completely ſaturated with oxigene: but when the acids are not completely ſaturated with that principle, the name of the neutral ſalt then terminates in *ite*. We have given more inſtances of neutral ſalts formed from thoſe acids which are beſt known and moſt uſed, than of the ſalts formed with the acids which are leſs common *.

The

* The neutral ſalts are now exceedingly numerous. There are 29 acids known, which, as each of them may be ſaturated by 4 ſoluble earths, 3 alkalis, and 14 metallic oxides which are not acidifiable (for it appears, that the acidifiable oxides, ſuch as thoſe of arſenic, molybdena, and tungſten, do not neutraliſe the mineral acids), form 609 ſpecies of compound ſalts. Add to this, that 5 of theſe acids, the nitric, the ſulphuric, the muriatic, the acetic, and the phoſphoric, combine with neutraliſable baſes in both of their different ſtates; and that a number of acids, ſuch as the ſulphureous, the tartareous, the oxalic, and the arſenic, admit of ſaturation with different quantities of the baſe, in conſequence of which they form what are called *acidula*, of which there are already 8 different ſpecies very well known *. With this addition, the number of the neutral ſalts will amount to 722 ſpecies, the names of which may be methodically formed, from the 46 or 48 examples given in this table.

* Such are, *acidulous ſulphate of potaſh*, or vitriolated tartar with an exceſs of the acid; *tartarites*, or *acidulous oxalates of potaſh*, *ſoda*, and *ammoniac*, or creams of tartar, and ſalts of ſorrel, artificially prepared with the pure tartareous and oxalic acids combined with a ſmall quantity of the alkaline baſes; and the *acidulous arſeniate of potaſh*, or arſenical neutral ſalt of Macquer.

The names of 18 genera of neutral falts in this table terminate in *ate*. This termination of their name fhews, that the acid to which they owe their formation is known only in the ftate of the complete faturation of the acidifiable bafe with oxigene: and accordingly, the names of all the acids to which thefe neutral falts belong, terminate in *ic*, by the rules of our nomenclature, as appears in the 3d column.

The 14th, 15th, 21ft, and 22d divifions, exhibit names of neutral falts, terminating in *ite*. The termination of thefe falts is meant to indicate, that in the acids from which they are formed, there is an excefs of the acidifiable bafe.

There are other divifions in this column, exhibiting both the terminations *ate* and *ite*: thus, in the 5th column, *nitrate* and *nitrite*; in the 7th, *fulphate*, and *fulphite*; in the 8th, *phofphate* and *phofphite*; in the 13th, *acetate* and *acetite*. Thefe terminations fhew, that the falts to which they belong owe their formation to acids exifting in two different ftates. *Nitrates*, for inftance, are formed by the *nitric* acid, in which the acidifiable bafe is fully faturated with oxigene; and *nitrites* again are formed by the *nitrous* acid, in which the bafe is not completely faturated with the acidifying principle.

In fome others of thefe divifions, there are neutral falts different from any of the above. Thus, in the 9th divifion, we have *oxigenated muriate of potafh*, the combination of the oxigenated muriatic acid of potafh, a falt very different from fimple muriate of potafh, and which M. Berthollet has difcovered to poffefs the property of detonizing on burning coals. In other divifions in this fame column, we have expreffed faline combinations in which the acids predominate, by adding to the

fyftematic

fyftematic name of thefe falts, the epithet *acidulous ;*
Thus, the 14th divifion contains *acidulous tartarite of
potafh ;* and the 16th, *acidulous oxalate of potafh.* Laft-
ly, by the expreffion *fuperfaturated*, we diftinguifh thofe
neutral falts in which the bafe predominates, as may be
feen in the 8th divifion, in which is, *fuperfaturated
phofphate of foda ;* and in the 10th, in which we have
borax, or *fuperfaturated borate of foda.*

By reflecting on the ftrict etymological method which
we have obferved in affixing thefe denominations to
neutral falts; and confidering, that, in the old nomen-
clature, there appears fcarce any analogy between the
names of falts of a fimilar nature ; the Reader will
perceive the reafon of the changes which appear in this
column, which are more numerous than thofe which
any of the others exhibits ; though there is actually no-
thing new in it, but the variation of two terminations
of names which were before in ufe.

Column VI.

The fixth and laft column of this table, which com-
prehends fimple fubftances combined in their natural
ftate, and neither oxigenated nor acidified,—as the title
fhews, is one of the fhorteft, and contains but few com-
pounds.   The lower divifions, from the 31ft to the 38th,
contain compounds confifting of different metals, which
we fuffer to retain the names of *alloys* and *amalgams*, by
which they have been hitherto known.   Above the 31ft
divifion, there are only three which exhibit a new no-
menclature, founded on the fame principles with the
foregoing.   The fixth contains *carbure of iron ;*—a de-
nomination by which we have diftinguifhed the na-
tural combination of coal and iron, called *plumbago.*
The

The 7th divifion exhibits metallic fulphures, or natural combinations of fulphur with alkalis,—and fulphurated hydrogenous gas, or the folution of fulphur with hydrogenous gas. Laftly, in the 8th divifion, we exprefs, by the generic name of *metallic phofphures*, natural compounds of phofphorus with metals : Thus, to the name *fyderite*, we fubftitute the expreffion *phofphure of iron*, which plainly fignifies the combination of phofphorus with iron : and thefe three words, *carbure*, *fulphure*, and *phofphure*, differing only in the termination from names which are very well known, convey an accurate idea of fimilar combinations, and diftinguifh them from all other compounds.

Under thefe fix columns, we have placed a nomenclature of the principal compound bodies that are found in vegetables. In this part of the table, we merely felected from among the old names, thofe whofe fimplicity and plainnefs render them fuitable to our purpofes.

Such is the method which we have followed in forming the fyftem of names exhibited in this table. Thofe who make themfelves mafters of this table, which may very eafily be done, will readily perceive, that we have formed but very few new words, excepting fuch as were indifpenfably neceffary to denominate fubftances before unknown, fuch as the newly-difcovered acids. By tracing the order of the fubftances in the firft column, from which all the reft are derived, any perfon will fee, that we ufe no new words but *oxigene*, *hydrogene*, and *azote*. As to the words *caloric*, *carbone*, *filice*, *ammoniac*, both thefe and all their derivations are formed by a very flight change from names before well known and much ufed. It is plain, therefore, that our new nomenclature differs from the old, in nothing but new terminations;

and

and that, if thefe changes render the ftudy eafier, and the language of the fcience more intelligible,—above all, if they enable us to exprefs ourfelves with unequivocal pre-cifion,—as the trial of this nomenclature that has been made in the years 1777 and 1778, in the courfe of Lec-tures on Chemiftry delivered in the King's Garden and the Lyceum, affords us reafon to hope ;—the reformation which we wifh to introduce on fo fimple a method, can-not but be highly favourable to the progrefs of Chemiftry.

A D V E R-

ADVERTISEMENT

CONCERNING THE

TWO TABLES OF SYNONYMOUS NAMES.

TO our general table of the fyftematic Nomencla-
ture, exhibiting the whole of our fyftem, we
have thought proper to add a lift of fynonymes, con-
taining all the words neceffary in denominating chemical
preparations. This lift of fynonymes is given in the
form of two vocabularies. In the firft of thefe, are
the old names, difpofed in alphabetical order; and, op-
pofite to them, the correfpondent, new, or newly adopt-
ed names. This vocabulary not only fhews the names
which we have given to the different chemical compounds,
but perfons not very well acquainted with the prepara-
tions in general, the old names of which do not at all
explain their nature, will find, in the new fynonymous
words, a fort of definition of the fubftances to which
they are affixed, fufficiently plain and diftinct, to enable
them to underftand their natures.

In the fecond vocabulary, the order of the new and
the old names is directly contrary to that of the firft;
and we hope it will be found no lefs ufeful.

In it, the new names appear in alphabetical order;
and, oppofite to them, are exhibited the correfponding
old names. In this, our object was, to give a complete
lift of fynonymous terms, in order that ftudents might
not, in this fcience, be under the fame difficulties as in

fome others, particularly in Mineralogy and Botany, in which the vaft variety of different names given to the fame thing, has produced a degree of confufion and obfcurity, which the labours of fome of the moft indefatigable of men have not been fufficient to remove.

In this new vocabulary, we fhew that the fame fubftance has frequently received eight, ten, or twelve different names; that moft of thefe names bear no relation to the things to which they are affixed;—which indeed could not but happen in a fcience in which the firft writers fought to conceal every thing under a veil of myftery; and in the hiftory of which we cannot trace the feveral periods at which thofe who have cultivated it, have attained an accurate knowledge of different compounds. But, to avoid tedioufnefs and obfcurity, we have taken care not to exhibit here, the names anciently given to different fubftances by the alchemifts, which, as they were founded on abfurd or chimerical ideas, have happily been forgotten fince chemiftry has begun to make equal progrefs with Natural Philofophy.

Each of thefe tables of fynonymes, therefore, has its ufe. The firft may be ufed as a dictionary in reading books on chemiftry, that have been publifhed before this period, as it gives the new name correfponding to every old name which can occur in fuch works. In this, as well as in the following, we have given only the names of fimpler compound bodies, and of chemical preparations. The names of the operations we have not given, as we have made no change upon them. The fecond lift of fynonymes contains more words than the firft; for, in it, there are a good many compounds, the knowledge of which we owe to late experiments, and which, till within thefe few years, had no names. It may therefore be confidered as being in fome degree an

                                                      inventory

inventory of the chemical knowledge which we at pre-
fent poffefs.

In both thefe lifts, there are fome fynonymous words
among the new names. We retain them, becaufe fome
of them are very generally ufed, and becaufe fome choice
of expreffions with different terminations is neceffary
to give variety to difcourfe, and to prevent a difgufting
monotony. Thus, for inftance, the word expreffive of
the bafe of neutral falts, may be either a fubftantive or
an adjective, at the pleafure of the writer. In books on
chemiftry, there may be fome words found that do not
appear in our vocabularies; but the nature of the com-
pounds to which thefe have been applied, is not yet well
known; and thofe who confider to what ftrict laws we
have here fubjected ourfelves, will readily be fenfible,
that it would have been impoffible for us to give names
to combinations but imperfectly known.

We have added fome definitions to feveral general or
particular names, either when we have been doubtful of
the nature of the compounds to which they belong, or
in fpeaking of bodies but lately difcovered. The fecond
table, which exhibits the new names in alphabetical or-
der, with the correfponding old names, gives at the
fame time a Latin tranflation of the new names: In mak-
ing out this tranflation, we have ftill adhered to the
fame rules. Uniformity of termination, and the laws of
derivation, are the two principles by which we have
been uniformly directed. Our Nomenclature would have
been imperfect, if we had neglected to offer to philofo-
phers of all nations an uniform mode of expreffing them-
felves, which might make them generally underftood.
As the fcience improves, fuch new names as fhall be-
come neceffary may be added upon the fame plan.

E R R A-

E R R A T A.

V O L. I.

P. 9. L. 14.		For *called*, read *able*.
49.	12. from the top.	For *sulphureous*, read *sulphuric*.
59.	8. from the top.	For *desert*, read *detach*.
107.	12. from the bottom.	For *calonic*, read *caloric*.
244.	12. from the bottom.	For *sulphur*, read *sulphure*.
306.	11. from the bottom.	For *acid*, read *caustic*.
314.	1. of the note.	For *acids*, read *alkalis*.
319.	6. from the bottom.	Dele *the*.
355.	11. from the top.	For *solid*, read *elastic fluid*.
448.	6. & 9. from the bottom.	For *soda*, read *potash*.

V O L. II.

581.	6. from the bottom.	For *bitumen*, read *bitumens*.
639.	9. from the top.	For *acidulæ*, read *acidula*.
639.	11. —————	For *acidula*, read *acidulum*.

V O L. III.

15.	7. from the bottom.	For *Sicilly*, read *Sicily*.

For *alumines*, wherever it occurs, read *alumina*.

COMPARATIVE VIEW

OF

ANCIENT AND MODERN NAMES

OF

CHEMICAL SUBSTANCES,

IN ALPHABETICAL ORDER.

OLD NAMES.	NEW OR ADOPTED NAMES.
	A
ACETATED *Ammoniac.*	{Acetite, ammoniacal. {Acetite of ammoniac.
Acetated lime.	{Acetite, calcareous. {Acetite of lime.
Acetated clay.	{Acetite, aluminous. {Acetite of aluminous earth.
Acetated copper.	Acetite of copper.
Acetated magnesia.	{Acetite, magnesian. {Acetite of magnesia.
Acetated lead.	Acetite of lead.
Acetated soda.	Acetite of soda.
Acetated potash.	Acetite of potash.
Acetated zinc.	Acetite of zinc.
Acetated iron.	Acetite of iron.
Acetated mercury.	{Acetite of mercury. {Acetite, mercurial.

OLD NAMES.	A	NEW NAMES.
Acid, acetous.		Acid, acetous.
Acid, aerial.		Acid, carbonic.
Acid, arſenical.		Acid, arſenic.
Acid of benzoin.		Acid, benzoic.
Acid of borax.		Acid, boracic.
Acid, carbonaceous.		Acid, carbonic.
Acid of citrons.		Acid, citric.
Acid, cretaceous.		Acid, carbonic.
Acid of ants.		Acid, formic.
Acid of apples.		Acid, malic.
Acid, benzonic.		Acid, benzoic.
Acid of ſalt.		Acid, muriatic.
Acid of ſulphur.		Acid, ſulphuric.
Acid of amber.		Acid, ſuccinic.
Acid of ſugar.		Acid, oxalic.
Acid of tallow.		Acid, ſebacic.
Acid of vinegar.		Acid, acetous.
Acid of Wolfram, according to Meſſrs. D'Elhuyar.		Acid, tunſtic.
Acid, fluoric.		Acid, fluoric.
Acid, formicine.		Acid, formic.
Acid, galactic.		Acid, lactic.
Acid, gallic.		Acid, gallic.
Acid, lignic.		Acid, pyro-ligneous.
Acid, lithiaſic.		Acid, lithic.
Acid, maluſian.		Acid, malic.
Acid, marine.		Acid, muriatic.
Acid, dephlogiſticated marine.		Acid, oxigenated muriatic.
Acid, mephitic.		Acid, carbonic. *
Acid, molybdic.		Acid, molybdic.
Acid, white nitrous.		Acid, nitric.
Acid, nitrous, without gas.		Acid, nitric.
Acid, dephlogiſticated nitrous.		Acid, nitric.
Acid, phlogiſticated nitrous.		Acid, nitrous.
Acid, oxaline.		Acid, oxalic.
Acidum perlatum.		Superſaturated phoſphate of ſoda.
Acid, dephlogiſticated phoſphoric.		Acid, phoſphoric.

# of Chemical Substances.

OLD NAMES. A	NEW NAMES.
Acid, phlogisticated phosphoric.	Acid, phosphorous.
Acid, saccharine.	Acid, oxalic.
Acid, sacchalactic.	Acid, saccho-lactic.
Acid, sebaceous.	Acid, sebacic.
Acid, sedative.	Acid, boracic.
Acid, sparry.	Acid, fluoric.
Acid, sulphureous.	Acid, sulphureous.
Acid, syrupous.	Acid, pyro-mucous.
Acid, tartareous.	Acid, tartareous.
Acid, tungstic.	Acid, tunstic.
Acid, vitriolic.	Acid, sulphuric.
Acid, phlogisticated vitriolic.	Acid, sulphureous.
Acidum pingue.	Imaginary principle of Meyer.
Affinities.	Chemical affinities or attractions.
Aggregation.	Aggregation.
Aggregates.	Aggregates.
Air, vitriolic acid.	Sulphureous acid gas.
Air, alkaline.	Ammoniacal gas.
Air, dephlogisticated.	Oxigenous gas, or vital air.
Air, atmospheric.	Atmospheric air.
Air of fire, Scheele's.	Oxigenous gas.
Air, factitious.	Carbonic acid gas.
Air, fixed.	Carbonic acid gas.
Air, impure.	Azotic gas.
Air, inflammable.	Hydrogenous gas.
Air of sulphur, stinking.	Sulphurated hydrogenous gas.
Air, putrid.	
Air of Hales, solid.	Carbonic acid gas.
Air, vitiated.	Azotic gas.
Air, vital.	Oxigenous gas.
Alkahest.	Universal solvent, the existence of which was supposed by the Alchemists.
Alkahest of Respour.	Potash mixed with oxide of zinc.
Alkahest of Van Helmont.	Carbonate of potash.
Alkalis, in general.	Alkalis.
Alkali of tartar, fixed, not caustic.	Carbonate of potash

3 A 2

OLD NAMES.	A	NEW NAMES.
Alkalis, caustic.		Alkalis.
Alkalis, effervescent.		Alkaline carbonates.
Alkali of tartar, fixed, caustic.		Potash.
Alkali, vegetable fixed.		Carbonate of potash.
Alkali, caustic marine.		Soda.
Alkali, marine, not caustic.		Carbonate of soda.
Alkali, aerated mineral.		Carbonate of soda.
Alkali, caustic mineral.		Soda.
Alkali, effervescent mineral.		Carbonate of soda.
Alkali, phlogisticated.		{ Ferruginous prussiate of potash, not saturated.
Alkali, Prussian.		Ferruginous prussiate of potash.
Alkali, aerated vegetable.		Carbonate of potash.
Alkali, caustic vegetable.		Potash.
Alkali, caustic volatile.		Ammoniac.
Alkali, concrete volatile.		Ammoniacal carbonate.
Alkali, effervescent volatile.		Ammoniacal carbonate.
Alkali, fluor volatile.		Ammoniac.
Alkali, urinous.		Ammoniac.
Alloy of Metals.		Alloy.
Alum.		{ Sulphate of alumines. Aluminous sulphate.
Alum, marine.		{ Muriate of alumines. Aluminous muriate.
Alum, nitrous.		{ Nitrate of alumines. Aluminous nitrate.
Amalgam of silver.		Amalgam of silver.
Amalgam of bismuth.		Amalgam of bismuth.
Amalgam of copper.		Amalgam of copper.
Amalgam of tin.		Amalgam of tin.
Amalgam of gold.		Amalgam of gold.
Amalgam of lead.		Amalgam of lead.
Amalgam of zinc.		Amalgam of zinc.
Amber, yellow.		Amber.
Ammoniac, arsenical.		{ Ammoniacal arseniate. Arseniate of ammoniac.
Ammoniac, cretaceous.		{ Ammoniacal carbonate. Carbonate of ammoniac.

OLD NAMES.	A.	NEW NAMES.

Ammoniac, nitrous. { Ammoniacal nitrate. / Nitrate of ammoniac. }

Ammoniac, phosphoric. { Ammoniacal phosphate. / Phosphate of ammoniac. }

Ammoniac, sparry. { Ammoniacal fluate. / Fluate of ammoniac. }

Ammoniac, tartareous. { Ammoniacal tartarite. / Tartarite of ammoniac. }

Ammoniac, vitriolic. { Ammoniacal sulphate. / Sulphate of ammoniac. }

Antimony, ore of. Native sulphure of antimony.

Antimony, crude. Sulphure of antimony.

Antimony, diaphoretic. White oxide of antimony by nitre.

Aqua stygia. { Nitro-muriatic acid by ammoniacal muriate. }

Aquila alba. { Mild sublimated mercurial muriate. }

Arcanum duplicatum. Sulphate of potash.

Arsenic, regulus of. Arsenic.

Arsenic, white calx of. Oxide of arsenic.

Arsenic, red. Red sulphurated oxide of arsenic.

Arseniate of potash. Arseniate of potash.

Attractions, elective. Elective attractions.

Azure of cobalt, or of four fires. { Vitreous oxide of cobalt with siliceous earth. }

B

Barotes. Barytes.

Barotes, effervescent. Carbonate of barytes.

Base of vital air. Oxygene.

Base of marine salt. Soda.

Balsams of Bucquet. Balsams.
 See the new Nomenclature.

Balsam of sulphur. Sulphure of volatile oil.

Benzoin. Benzoin.

Benzones. Benzoates.

OLD NAMES.	B	NEW NAMES.
Butter of antimony.		Sublimated muriate of antimony.
Butter of arfenic.		Sublimated muriate of arfenic.
Butter of bifmuth.		Sublimated muriate of bifmuth.
Butter of tin.		Sublimated muriate of tin.
Baume's folid butter of tin.		Concrete muriate of tin.
Butter of zinc.		Sublimated muriate of zinc.
Bezoar mineral.		Oxide of antimony.
Bifmuth.		Bifmuth.
Bitumens.		Bitumens.
Blende, or *falfe galena.*		Sulphure of zinc.
Blue, Berlin.		Pruffiate of iron.
Blue, Pruffian.		Pruffiate of iron.
Borax, ammoniacal.		Ammoniacal borate.
Borax, argillaceous.		{ Aluminous borate. { Borate of alumines.
Borax, crude.		{ Borax of foda, *or* borate fuper- { faturated with foda.
Borax, calcareous.		{ Calcareous borate. { Borate of lime.
Borax of antimony.		Borate of antimony.
Borax of cobalt.		Borate of cobalt.
Borax of copper.		Borate of copper.
Borax of zinc.		Borate of zinc.
Borax, magnefian.		{ Magnefian borate. { Borate of magnefia.
Borax, martial.		Borate of iron.
Borax, mercurial.		Borate of mercury.
Borax, ponderous or *barotic.*		{ Barytic borate. { Borate of barytes.
Borax, vegetable.		Borate of potafh.
Brafs, bronze.		{ Alloy of copper and tin, brafs { or bronze.

C

Cameleon, mineral.		Oxide of manganefe and potafh.
Camphor.		Camphor.

OLD NAMES.	C	NEW NAMES.

Camphorites, (*salts.*)   Camphorates.

Causticum.   Imaginary principle of Meyer.

Ceruse.   { White oxide of lead by acetous acid, *mixed with chalk.*

Ceruse of antimony.   { White oxide of antimony by precipitation.

Coal, pure.   Carbone.

Calx of antimony, vitrified.   Vitreous oxide of antimony.

Calces, metallic.   Metallic oxides.

Cinnabar.   Red sulphurated oxide of mercury.

Citrates, (*salts.*)   Citrates.

Cobalt, or *cobolt.*   Cobalt.

Colcothar.   Red oxide of iron by sulphuric acid.

Copperas, white.   Sulphate of zinc.

Copperas, green.   Sulphate of iron.

Copperas, blue.   Sulphate of copper.

Chalk, ammoniacal.   Ammoniacal carbonate.

Chalk, barotic.   Barytie carbonate.

Chalk of lead.   Carbonate of lead.

Chalk of soda.   Carbonate of soda.

Chalk of zinc.   Carbonate of zinc.

Chalk, magnesian.   { Magnesian carbonate. / Carbonate of magnesia.

Chalk, martial.   Carbonate of iron.

Chalk, or *calcareous spar.*   { Calcareous carbonate. / Carbonate of lime.

Clay.   { Argilla, mixture of alumines and silices.

Clay, pure.   Alumines.

Clay, cretaceous.   { Aluminous carbonate. / Carbonate of alumines.

Clay, sparry.   { Aluminous fluate. / Fluate of alumines.

Cream of lime.   Calcareous carbonate.

Cream or *crystals of tartar.*   Acidulous tartarite of potash.

Crystal mineral.   { Nitrite of potash, mixed with sulphate of potash.

Crystals of soda.   Crystallized nitrate of silver.

3 A 4

Old Names	New Names
Cryftals of the moon.	Cryftallized carbonate of foda.
Cryftals of Venus.	Cryftallized acctite of copper.
Crocus metallorum.	{ Semi-vitreous fulphurate oxide of antimony.
Copper.	Copper.
Copper, yellow.	{ Alloy of copper and zinc, *or* latten.

D

Diamond.	Diamond.

E

Emetic.	Antimonial tartarite of potafh.
Empyreal air.	Oxigenous gas.
Effences.	Volatile oils.
Ether, acctous.	Acetic æther.
Ether, marine.	Muriatic æther.
Ether, nitrous.	Nitric æther.
Ether, vitriolic.	Sulphuric æther.
Ethiops, martial.	Black oxide of iron.
Ethiops, mineral.	{ Black fulphurated oxide of mercury.
Ethiops per fe.	Blackifh mercurial oxide.
Extract.	Extractive principle.

F

Feculum of plants.	Feculum.
Flowers, ammoniacal of copper.	{ Sublimated ammoniacal muriate of copper.
Flowers, martial ammoniacal.	{ Sublimated ammoniacal muriate of iron.
Flowers, filver of regulus of antimony.	} Sublimated oxide of antimony.

OLD NAMES.	F	NEW NAMES.

Old Names	New Names
Flowers of arsenic.	Sublimated oxide of arsenic.
Flowers of benzoin.	Sublimated benzoic acid.
Flowers of bismuth.	Sublimated oxide of bismuth.
Flowers of tin.	Sublimated oxide of tin.
Flowers, metallic.	Sublimated metallic oxides.
Flowers of sulphur.	Sublimated sulphur.
Flowers of zinc.	Sublimated oxide of zinc.
Fluids, aeriform.	Gases.
Fluids, elastic.	Gases.
Fluor, ammoniacal.	{ Ammoniacal fluate. Fluate of ammoniac.
Fluor, argillaceous.	{ Aluminous fluate. Fluate of alumines.
Fluor of potash.	Fluate of potash.
Fluor of soda.	Fluate of soda.
Fluor, magnesian.	{ Magnesian fluate. Fluate of magnesia.
Fluor, heavy.	{ Barytic fluate. Fluate of barytes.
Formiates, (salts.)	Formiates.

G

Old Names	New Names
Galactes, (salts.)	Lactates.
Gas, acetous acid.	Acetous acid gas.
Gas, cretaceous acid.	Carbonic acid gas.
Gas, marine acid.	Muriatic acid gas.
Gas, aerated muriatic acid.	Oxigenated muriatic acid gas.
Gas, nitrous acid.	Nitrous acid gas.
Gas, sparry acid.	Fluoric acid gas.
Gas, sulphureous acid.	Sulphureous acid gas.
Gas, alkaline.	Ammoniacal gas.
Gas, hepatic.	Sulphurated hydrogenous gas.
Gas, inflammable.	Hydrogenous gas.
Gas, carbonaceous inflammable.	Carbonated hydrogenous gas.
Gas, inflammable, of marshes.	{ Hydrogenous gas of marshes, (a mixture of carbonated hydrogenous gas with azotic gas.)

OLD NAMES.	G	NEW NAMES.

Gas, mephitic. — Carbonic acid gas.
Gas, phlogisticated. — Azotic gas.
Gas, nitrous. — Nitrous gas.
Gas, phosphoric, of M. Gengembre. — Phosphorated hydrogenous gas.
Gas, Prussian. — Prussic acid gas.
Gazeous waters. — { Waters impregnated with carbonic acid.
Gilla vitrioli. — Sulphate of zinc.
Gluten of wheat. — Gluten, or glutinous principle.
Gold. — Gold.
Gold, fulminating. — Ammoniacal oxide of gold.

H

Hepars. — Sulphures.
Heat, latent. — Caloric.

I

Ink, sympathetic, by cobalt. — Muriate of cobalt.
Iron, or *mars.* — Iron.
Iron, aerated. — Carbonate of iron.
Iron of water. — Phosphate of iron.
Jupiter. — Tin.

K

Kermes, mineral. — { Red sulphurated oxide of antimony.

L

Latten. — Alloy of copper and zinc, *or* latten.
Lapis causticus. — Concrete potash *or* soda.
Limestone. — Carbonate of lime.
Lixivium of soapmakers. — Solution of soda.
Lignites, (*salts.*) — Pyro-lignites.

OLD NAMES.	L	NEW NAMES.

OLD NAMES.	NEW NAMES.
Lilium of Paracelsus.	Alcohol of potash.
Liquor of flints.	Siliceous potash in liquor.
Liquor, Boyle's fuming.	{ Ammoniacal sulphure. { Sulphure of ammoniac.
Liquor, fuming, of Libavius.	Fuming muriate of tin.
Litharge.	{ Semi-vitreous oxide of lead, *or* { litharge.
Liquor saturated with the co-louring part of Prussian blue.	Prussiate of potash.
Light.	Light.
Luna.	Silver.
Luna, corneous.	Muriate of silver.
Liver of antimony.	Sulphurated oxide of antimony.
Liver of arsenic.	Arsenical oxide of potash.
Liver, volatile alkaline of sulphur.	{ Ammoniacal sulphure. { Sulphure of ammoniac.
Liver, antimoniated, of sulphur.	Antimoniated alkaline sulphure.
Liver, barotic, of sulphur.	{ Barytic sulphure. { Sulphure of barytes.
Liver, calcareous, of sulphur.	{ Calcareous sulphure. { Sulphure of lime.
Liver, magnesian, of sulphur.	{ Sulphure of magnesia. { Magnesian sulphure.
Livers of sulphur.	Alkaline sulphures.
Livers of sulphur, earthy.	Earthy sulphures.
Lead, or saturn.	Lead.
Lead, corneous.	Muriate of lead.
Lead, spathose.	Carbonate of lead.

M

OLD NAMES.	NEW NAMES.
Magistery of bismuth.	Oxide of bismuth by nitric acid.
Magistery of sulphur.	Precipitated sulphur.
Magistery of lead.	Precipitated oxide of lead.
Magnesia, white.	Carbonate of magnesia.
Magnesia of Bergman, aerated.	Carbonate of magnesia.
Magnesia, caustic.	Magnesia.

OLD NAMES.	M	NEW NAMES.

Magnefia, cretaceous. — Carbonate of magnefia.
Magnefia, effervefcent. — Carbonate of magnefia.
Magnefia, fluorated. — Fluate of magnefia.
Magnefia, black. — Black oxide of manganefe.
Magnefia, fparry. — Fluate of magnefia.
Malufites, (falts.) — Malites of potafh, foda, &c.
Maffcot. — Yellow oxide of lead.
Matter of heat. — Caloric.

Matter of fire. { *This word has been ufed to fignify* light, caloric, *and* phlogifton.

Materia perlata of Kerkringius. { White oxide of antimony by precipitation.

Mephite, ammoniacal. { Ammoniacal carbonate. Carbonate of ammoniac.

Mephite, barotic. { Barytic carbonate. Carbonate of barytes.

Mephite, calcareous. { Calcareous carbonate. Carbonate of lime.

Milk of lime. — Lime diluted in water.

Mephite of magnefia. { Magnefian carbonate. Carbonate of magnefia.

Mephite of lead. — Carbonate of lead.
Mephite of zinc. — Carbonate of zinc.
Mephite, martial. — Carbonate of iron,
Matter, colouring, of Pruffian blue. Pruffic acid.
Mercury. — Mercury.
Mercury of metals. — Imaginary principle of Beccher.
Mercury, mild. — Mild mercurial muriate.

Mercury, white precipitated. { Mercurial muriate by precipitation.

Minium. — Red oxide of lead, *or* minium.
Mofetes, atmofpheric. — Azotic gas.
Molybdes, (falts.) — Molybdates.

Molybde, ammoniacal. { Ammoniacal molybdate. Molybdate of ammoniac.

Molybde, barotic. { Barytic molybdate. Molybdate of barytes.

Molybde of potafh. — Molybdate of potafh.

OLD NAMES.	M	NEW NAMES.
Molybde of ſoda.		Molybdate of ſoda.
Molybdena.		Molybdena.
Mucilage.		Mucilage.
Muriates, (*ſalts.*)		Muriates.
Muriate of antimony.		Muriate of antimony.
Muriate of ſilver.		Muriate of ſilver.
Muriate of biſmuth.		Muriate of biſmuth.
Muriate of cobalt.		Muriate of cobalt.
Muriate of copper.		Muriate of copper.
Muriate of tin.		Muriate of tin.
Muriate of iron.		Muriate of iron.
Muriate of manganeſe.		Muriate of manganeſe.
Muriate of lead.		Muriate of lead.
Muriate of zinc.		Muriate of zinc.
Muriate or *regaline ſalt of platina.*		Nitro-muriate of platina.
Muriate or *regaline ſalt of gold.*		Muriate of gold.
Muriate, corroſive mercurial.		Corroſive mercurial muriate.

N

OLD NAMES.	NEW NAMES.
Natrum, or *natron.*	Carbonate of ſoda.
Nitre.	Nitrate of potaſh, *or* nitre.
Nitre, ammoniacal.	Ammoniacal nitrate.
Nitre, argillaceous.	Nitrate of alumines.
Nitre, calcareous.	{ Calcareous nitrate. { Nitrate of lime.
Nitre, cubic.	Nitrate of ſoda.
Nitre of ſilver.	Nitrate of ſilver.
Nitre of arſenic.	Nitrate of arſenic.
Nitre of biſmuth.	Nitrate of biſmuth.
Nitre of cobalt.	Nitrate of cobalt.
Nitre of copper.	Nitrate of copper.
Nitre of tin.	Nitrate of tin.
Nitre of iron.	Nitrate of iron.
Nitre of magneſia.	{ Magneſian nitrate. { Nitrate of magneſia.

OLD NAMES.	N	NEW NAMES.

Old Names	New Names
Nitre of manganefe.	Nitrate of manganefe.
Nitre of nickel.	Nitrate of nickel.
Nitre of lead.	Nitrate of lead.
Nitre of terra ponderofa.	{ Barytic nitrate. Nitrate of barytes.
Nitre of zinc.	Nitrate of zinc.
Nitre, fixed, by itfelf.	Carbonate of potafh.
Nitre, lunar.	Nitrate of filver.
Nitre, mercurial.	Nitrate of mercury.
Nitre, prifmatic.	Nitrate of potafh.
Nitre, quadrangular.	Nitrate of foda.
Nitre, rhomboidal.	Nitrate of foda.
Nitre, faturnine.	Nitrate of lead.

O

Old Names	New Names
Ochre.	Yellow iron ochre.
Oils, animal.	Volatile animal oils.
Oil of lime.	Calcareous muriate.
Oil of tartar per deliquium.	{ Potafh, mixed with carbonate of potafh, in a deliquefcent ftate.
Oil, philofopher's.	Empyreumatic fixed oils.
Oil of vitriol.	Sulphuric acid.
Oil of wine, fweet.	Ethereal oil.
Oils, empyreumatic.	Empyreumatic oils.
Oils, ethereal.	Volatile oils.
Oils, fat.	Fixed oils.
Oils, effential.	Volatile oils.
Oils by expreffion.	Fixed oils.
Ore of antimony.	Native fulphure of antimony.
Ore of iron, from marfhes.	{ Iron ore, holding in folution phofphate of iron.
Orpiment.	{ Yellow fulphurated oxide of arfenic.
Oxygene.	Oxygene.

P

Phlogiſton.	Imaginary principle of Stahl.
Philoſophic wool.	Sublimated oxide of zinc.
Phoſphate, ammoniacal.	{ Ammoniacal phoſphate. { Phoſphate of ammoniac.
Phoſphate, barotic.	{ Barytic phoſphate. { Phoſphate of barytes.
Phoſphate, calcareous.	{ Calcareous phoſphate. { Phoſphate of lime.
Phoſphate of magneſia.	{ Magneſian phoſphate. { Phoſphate of magneſia.
Phoſphate of potaſh.	Phoſphate of potaſh.
Phoſphate of ſoda.	Phoſphate of ſoda.
Phoſphorus of Baudouin.	Dry calcareous nitrate.
Phoſphorus of Kunckel.	Phoſphorus.
Phoſphorus of Homberg.	Dry calcareous muriate.
Ponderous ſtone.	Calcareous tunſtate.
Platina.	Platina.
Plaſter.	{ Calcareous ſulphate, *or* calcined { plaſter.
Plumbago.	Carbure of iron.
Pompholyx.	Sublimated oxide of zinc.
Potaſhes of commerce.	Impure carbonate of potaſh.
Putty of tin.	Grey oxide of tin.
Powder of Algaroth.	{ Oxide of antimony by muriatic { acid.
Powder of Count Palma. *Powder of Sentinelly.*	} Carbonate of magneſia.
Precipitate, white, by muriatic *acid.*	{ Mercurial muriate by precipi- { tation.
Precipitate of gold by tin, or *purple of Caſſius.*	{ Oxide of gold precipitated by { tin.
Precipitate, yellow.	{ Yellow oxide of mercury by { ſulphuric acid.
Precipitate per ſe.	Red oxide of mercury by fire.
Precipitate, red.	{ Red oxide of mercury by nitric { acid.

OLD NAMES.	P	NEW NAMES.

Principle, acidifying.   Oxygene.

Principle, aftringent.   Gallic acid.

Principle, carbonaceous.   Carbone.

Principle, inflammable.
  (See *phlogifton*.)

Principle, mercurial.   Imaginary principle of Beccher.

Principium forbile of M. Ludbock. Oxygene.

Pruffite, calcareous.   { Calcareous pruffiate.
                            { Pruffiate of lime.

Pruffite of potafh.   Pruffiate of potafh.

Pruffite of foda.   Pruffiate of foda.

Pyrites of copper.   Sulphure of copper.

Pyrites, martial.   Sulphure of iron.

Pyrophorus of Homberg.   { Carbonated fulphure of alumines.
                            { Pyrophorus of Homberg.

R

Realgar, or *realgal.*   Red fulphurated oxide of arfenic.

Regaltes, (falts formed with aqua regia.)   { Nitro-muriates.

Regia, aqua.   Nitro-muriatic acid.

Regulus.   { *A word ufed to denote the* pure
                  {   metallic, *in oppofition to* ores,
                  {   *and* oxides.

Regulus of antimony.   Antimony.

Regulus of arfenic.   Arfenic.

Regulus of cobalt.   Cobalt.

Regulus of manganefe.   Manganefe.

Regulus of molybdena.   Molybdena.

Regulus of fyderite.   Phofphure of iron.

Refins.   Refins.

Ruft of copper.   Green oxide of copper.

Ruft of iron.   Carbonate of iron.

Rubine of antimony.   Sulphurated oxide of antimony.

Red nitrated mercury.   { Red oxide of mercury by nitric
                         {   acid.

OLD NAMES.	NEW NAMES.

S

Saffron of mars.	Oxide of iron.
Saffron, aperient, of mars.	Carbonate of iron.
Saffron, aſtringent, of mars.	Brown oxide of iron.
Saffron of metals.	{ Semi-vitreous ſulphurated oxide of antimony.
Saltpetre.	Nitrate of potaſh, *or* nitre.
Saturn.	Lead.
Soaps, acid.	Acid ſoaps.
Soaps, alkaline.	Alkaline ſoaps.
Soaps, earthy, or *oleo-terrene combinations of M. Berthollet.*	{ Earthy ſoaps.
Soaps, metallic, or *elco-metallic combinations of M. Berthollet.*	{ Metallic ſoaps.
Soap of Starkey.	Saponula of potaſh.
Sebates, (*ſalts.*)	Sebates.
Salt, ammoniacal acetous.	{ Ammoniacal acetite. Acetite of ammoniac.
Salt, calcareous acetous.	{ Calcareous acetite. Acetite of lime.
Salt, acetous of clay.	{ Aluminous acetite. Acetite of alumines.
Salt, acetous of zinc.	Acetite of zinc.
Salt, magneſian acetous.	{ Magneſian acetite. Acetite of magneſia.
Salt, acetous martial.	Acetite of iron.
Salt, acetous mineral.	Acetite of ſoda.
Sal admirabile perlatum.	Superſaturated phoſphate of ſoda.
Sal Alembroth.	Ammoniaco-mercurial muriate.
Sal ammoniac.	{ Ammoniacal muriate. Muriate of ammoniac.
Salt, cretaceous ammoniacal.	Ammoniacal carbonate.
Sal ammoniac, fixed.	{ Calcareous muriate. Muriate of lime.
Sal ammoniacal, nitrous.	{ Ammoniacal nitrate. Nitrate of ammoniac.

OLD NAMES.	S	NEW NAMES.

Sal ammoniacal, (a secret of Glauber's.) — { Ammoniacal sulphate. / Sulphate of ammoniac.

Salt, bitter cathartic. — { Magnesian sulphate. / Sulphate of magnesia.

Salt, ammoniacal sedative. — { Ammoniacal borate. / Borate of ammoniac.

Salt, ammoniacal sparry. — { Ammoniacal fluate. / Fluate of ammoniac.

Salt, ammoniacal vitriolic. — { Ammoniacal sulphate. / Sulphate of ammoniac.

Salt, common. — Muriate of soda.

Salt, English. — { Ammoniacal carbonate. / Carbonate of ammoniac.

Salt of colcothar. — { Sulphate of iron, (*its particular state not well known.*)

Salt, kitchen. — Muriate of soda.

Salt, Glauber's. — Sulphate of soda.

Salt of Jupiter. — Muriate of tin.

Salt of milk. — Sugar of milk.

Salt of wisdom. — Ammoniaco-mercurial muriate.

Salt of Epsom. — { Magnesian sulphate. / Sulphate of magnesia.

Sal de Duobus. — Sulphate of potash.

Salt of Scheidschutz. — Sulphate of magnesia.

Salt of Sedlitz. — Sulphate of magnesia.

Salt of Segner. — Sebate of potash.

Salt of Seignette. — Tartarite of soda.

Salt of amber, obtained by crystallization. — } Crystallized succinic acid.

Salt of sorrel. — Acidulous oxalate of potash.

Salt, febrifuge, of Sylvius. — Muriate of potash.

Salt, fixed, of tartar. — Carbonate of potash not saturated.

Salt, fusible, of urine. — Phosphate of soda and ammoniac.

Sal gem. — Fossil muriate of soda.

Salt, marine. — Muriate of soda.

Salt, argillaceous marine. — { Aluminous muriate. / Muriate of alumines.

Salt, barotic marine. — { Barytic muriate. / Muriate of barytes.

OLD NAMES.	S	NEW NAMES.

Salt, calcareous marine. — { Calcareous muriate.
 Muriate of lime.

Salt, marine, of iron. — Muriate of iron.

Salt, marine, of zinc. — Muriate of zinc.

Salt, magnesian marine. — { Magnesian muriate.
 Muriate of magnesia.

Salt, native, of urine. — Phosphate of soda and ammoniac.

Salt, neutral arsenical, of Macquer. — Acidulous arseniate of potash.

Salt or *sugar of saturn.* — Acetite of lead.

Salt, polychrest, of Glaser. — Sulphate of potash.

Salt, polychrest, of Rochelle. — Tartarite of soda.

Salt, regaline, of gold. — Muriate of gold.

Salt, sedative. — Boracic acid.

Salt, sedative mercurial. — Borate of mercury.

Salt, sublimated sedative. — Sublimated boracic acid.

Salt, stanno-nitrous. — Nitrate of tin.

Salt, sulphureous, of Stahl. — Sulphate of potash.

Salt, vegetable. — Tartarite of potash.

Salt, volatile, of England. — Ammoniacal carbonate.

Salt, volatile, of amber. — Sublimated succinic acid.

Selenite. — Sulphate of lime.

Smalt. — { Oxide of cobalt vitrified with <br> silices, or *smalt.*

Soda, caustic. — Soda.

Soda, cretaceous. — Carbonate of soda.

Soda, spathose. — Fluate of soda.

Sulphur. — Sulphur.

Sulphur, gilded, of antimony. — { Sulphurated, orange, oxide of <br> antimony.

Spar, ammoniacal. — Ammoniacal fluate.

Spar, calcareous. — Carbonate of lime.

Spar, fluor. — Calcareous fluate.

Spar, ponderous. — Sulphate of barytes.

Spiritus sylvestris. — Carbonic acid.

Snow of antimony. — { White sublimated oxide of an-
 timony.

Spirit, acid, of wood. — Pyro-ligneous acid.

OLD NAMES.	S	NEW NAMES.

Spirit, volatile alkaline. — Gas ammoniac, *or* ammoniacal gas.
Spirit, ardent, or *spirit of wine.* — Alcohol.
Spirit of Mendererus. — Ammoniacal acetite.
Spirit of nitre. — Nitric acid diluted in water.
Spirit, fuming, of nitre. — Nitrous acid.
Spirit, dulcified, of nitre. — Nitric alcohol.
Spirit of salt. — Muriatic acid.
Spirit of sal ammoniac. — Ammoniac.
Spirit of wine. — Alcohol.
Spirit of vitriol. — Sulphuric acid diluted in water.
Spirit of Venus. — Acetic acid.
Spiritus rector. — Aroma.
Spirits, acid. — Acids diluted in water.
Spirit, volatile, of sal ammoniac. — Ammoniac diluted in water.
Sublimate, corrosive. — Corrosive muriate of mercury.
Sublimate, mild. — Mild muriate of mercury.
Lemon, or *citron juice.* — Citric acid.
Semi-metals. — Semi-metals.
Succinum. — Amber.
Stone, infernal. — Melted nitrate of silver.
Sugar. — Sugar.
Sugar candy. — Crystallized sugar.
Sugar of saturn. — Acetite of lead.
Sugar or *salt of milk.* — Sugar of milk.
Syderite. — Phosphate of iron.
Stearch. — Stearch.
Syderotete of M. de Morveau. — Phosphure of iron.
Steel. — Steel.
Stone in the bladder. — Lithic acid.

T

Tartar. — Acidulous tartarite of potash.
Tartar, ammoniacal. — Ammoniacal tartarite.
Tartar, antimoniated. — Antimoniated tartarite of potash.
Tartar, calcareous. — Tartarite of lime.

OLD NAMES.	T	NEW NAMES.

Tartar, chalybeate.	Ferruginous-tartarite of potaſh.
Tartar, cretaceous.	Carbonate of potaſh.
Tartar, crude.	Tartar.
Tartar, cupreous.	Tartarite of copper.
Tartar of magneſia.	Tartarite of magneſia.
Tartar of potaſh.	Tartarite of potaſh.
Tartar of ſoda.	Tartarite of ſoda.
Tartar, emetic.	Antimoniated tartarite of potaſh.
Tartar, ſoluble martial.	Ferruginous tartarite of potaſh.
Tartar, mephitic.	Carbonate of potaſh.
Tartar, mercurial.	Mercurial tartarite.
Tartar, ſaturnine.	Tartarite of lead.
Tartar, ſpathoſe.	Fluate of potaſh.
Tartar, ſoluble.	Tartarite of potaſh.
Tartar, ſtibiated.	Antimoniated tartarite of potaſh.
Tartar, tartariſed.	Tartarite of potaſh.
Tartar, tartariſed, containing antimony.	{ Tartarite of potaſh, with an addition of antimony.
Tartar, vitriolated.	Sulphate of potaſh.
Tartar, acrid tincture of.	Alcohol of potaſh.
Tinctures, ſpiritous.	Reſinous alcohol.
Terra animalis.	{ Calcareous phoſphate. Phoſphate of lime.
Terrene baſe of alum.	Alumina.
Terrene baſe of ponderous ſpar.	Barytes.
Terra calcaria.	Lime, *or* calcareous earth.
Terra aluminæ.	Alumina.
Terra foliata, cryſtallizable.	Acetite of ſoda.
Terra foliata tartari.	Acetite of potaſh.
Terra foliata mercurialis.	Acetite of mercury.
Terra foliata mineralis.	Acetite of ſoda.
Terra magneſiana.	Carbonate of magneſia.
Terra muriatica of M. Kirvan.	Magneſia.
Terra ponderoſa.	Barytes.
Terra ponderoſa, aerated.	Carbonate of barytes.
Terra ſilicea.	Silices, *or* ſiliceous earth.

OLD NAMES.	T	NEW NAMES.

Tungstic _falts._ — Tunftates.

Tungstic _falt, ammoniacal._ — Ammoniacal tunftate.

Tungstic _falt of potafh._ — Tunftate of potafh.

Turbith, _mineral._ — { Yellow mercurial oxide by ful-phuric acid.

Turbith, _nitrous._ — { Yellow mercurial oxide by nitrous acid.

Tin. — Tin.

Tin, _corneous._ — Muriate of tin.

V

Verdigris. — Green oxide of copper.

Verdigris _of commerce._ — { Acetite of copper, with an excefs of oxide of copper.

Venus. — Copper.

Verdet (Fr.), or _verdigris._ — Acetite of copper.

Verdigris, _diftilled._ — Cryftallized acetite of copper.

Vitrum antimonii. — { Vitreous fulphurated oxide of antimony.

Vivum argentum. — Mercury.

Vinegar, _diftilled._ — Acetous acid.

Vinegar _of faturn._ — Acetite of lead.

Vinegar, _radical._ — Acetic acid.

Vitriol, _ammoniacal._ — Ammoniacal fulphate.

Vitriol, _white._ — Sulphate of zinc.

Vitriol, _blue._ — Sulphate of copper.

Vitriol, _calcareous._ — Sulphate of lime.

Vitriol _of antimony._ — Sulphate of antimony.

Vitriol _of filver._ — Sulphate of filver.

Vitriol _of clay._ — Sulphate of alumines.

Vitriol _of bifmuth._ — Sulphate of bifmuth.

Vitriol _of lime._ — Calcareous fulphate.

Vitriol _of Cyprus._ — Sulphate of copper.

Vitriol _of cobalt._ — Sulphate of cobalt.

Vitriol _of copper._ — Sulphate of copper.

OLD NAMES.	V	NEW NAMES.

OLD NAMES.	NEW NAMES.
Vitriol of luna.	Sulphate of ſilver.
Vitriol of manganeſe.	Sulphate of manganeſe.
Vitriol of mercury.	Sulphate of mercury.
Vitriol of nickel.	Sulphate of nickel.
Vitriol of platina.	Sulphate of platina.
Vitriol of lead.	Sulphate of lead.
Vitriol of potaſh.	Sulphate of potaſh.
Vitriol of ſoda.	Sulphate of ſoda.
Vitriol of tin.	Sulphate of tin.
Vitriol of zinc.	Sulphate of zinc.
Vitriol, magneſian.	Sulphate of magneſia.
Vitriol, martial.	Sulphate of iron.
Vitriol, green.	Sulphate of iron.

W

OLD NAMES.	NEW NAMES.
Water.	Water.
Water, aerated.	Carbonic acid.
Water, lime.	Lime-water.
Water, Pruſſian-lime.	Pruſſiate of lime.
Water, diſtilled.	Diſtilled water.
Water, ſtrong, or *aqua fortis.*	Nitric acid of commerce.
Waters, gazeous.	{ Waters impregnated with carbonic acid.
Waters, mother.	Saline deliqueſcent reſidue.
Water, mercurial.	{ Nitrate of mercury in a ſtate of ſolution.
Water, royal, or *aqua regia.*	Nitro-muriatic acid.
Waters, acidulous.	{ Acidulous waters, or waters impregnated with carbonic acid.
Waters, hepatic.	{ Sulphureous or ſulphurated waters.
Wolfram of Meſſrs d' Elhuyar.	Tungſten.

Z

OLD NAMES.	NEW NAMES.
Zinc.	Zinc.
Zaffre.	{ Grey oxide of cobalt, with ſiliceous earth, or *zaffre.*

DIC-

DICTIONARY

FOR THE

NEW CHEMICAL NOMENCLATURE.

NEW NAMES.	OLD NAMES.

A

ACETATES.
Acetas, tis. f. m.

{ These are falts formed by the combination of the acetic acid (or radical vinegar) with different bafes. The following names, with which there are none fynonymous in the ancient Nomenclature, belong to this genus.

Acetate, aluminous.
———— of alumines.
Acetas aluminofus.
Acetate, ammoniacal.
———— of ammoniac. *
Acetas ammoniacalis.

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* For the future, we fhall not repeat thefe two modes of expreffing the bafe of a neutral falt together, but ufe them indifferently. Thefe inftances already given, are enough to fhow, that either the fubftantive or the adjective may be ufed, at pleafure.

This obfervation extends alfo to the Latin Nomenclature.

Acetate of antimony.
   Acetas ſtibii.

Acetate of ſilver.
   Acetas argenti.

Acetate of arſenic.
   Acetas arſenici.

Acetate of barytes.
   Acetas barytis, or *barytæ.*

Acetate of biſmuth.
   Acetas biſmuthi.

Acetate of lime.
   Acetas calcis.

Acetate of cobalt.
   Acetas cobalti.

Acetate of copper.
   Acetas cupri.

Acetate of tin.
   Acetas ſtanni.

Acetate of iron.
   Acetas ferri.

Acetate of magneſia.
   Acetas magneſiæ.

Acetate of manganeſe.
   Acetas magneſii.

Acetate of mercury.
   Acetas hydrargyri.

Acetate of molybdena.
   Acetas molybdeni.

Acetate of nickel.
   Acetas niccoli.

Acetate of gold.
   Acetas auri.

Acetate of platina.
   Acetas platini.

Acetate of lead.
   Acetas plumbi.

Acetate of potash.
  Acetas potassæ.
Acetate of soda.
  Acetas sodæ.
Acetate of tungsten.
  Acetas tunsteni.
Acetate of zinc.
  Acetas zinci.

Acetite.   { Salts formed by the union of
  Acetis, itis. s. m.   { the acetous acid, or distilled vi-
                                { negar, with different bases.

Acetite, aluminous.   { *Acetited clay.*
  Acetis aluminosus.   { *Acetous salt of clay.*

Acetite, ammoniacal.   { *Ammoniacal acetite.*
  Acetis ammoniacalis.   { *Ammoniacal acetous salt.*
                               { *Spirit of Mendererus.*

Acetite of antimony.
  Acetis stibii.
Acetite of silver.
  Acetis argenti.
Acetite of arsenic.   { *Fuming arsenico-acetous liquor of*
  Acetis arsenicalis.   {   *M. Cadet.*
Acetite of barytes.
  Acetis baryticus.
Acetite of bismuth.
  Acetis bismuthi.
Acetite of lime.   { *Acetited lime.*
  Acetis calcareus.   { *Calcareous acetous salt.*
Acetite of cobalt.
  Acetis cobalti.

Acetite of copper.   { *Acetited copper.*
  Acetis cupri.   { *Verdigris.*
                               { *Distilled verdigris of commerce.*
                               { *Crystals of Venus.*

Acetite of tin.
  Acetis stanni.
Acetite of iron.   { *Acetited iron.*
  Acetis ferri.   { *Martial acetous salt.*

NEW NAMES.	A	OLD NAMES.

Acerite of magnefia.
    Acetis magnefiæ.
{ *Magnefian acetous falt.*
{ *Acetited magnefia.*

Acetite of mercury.
    Acetis hydrargyri.
{ *Acetited mercury.*
{ *Terra foliata mercurialis.*

Acetite of molybdena.
    Acetis molybdeni.

Acetite of nickel.
    Acetis niccoli.

Acetite of gold.
    Acetis auri.

Acetite of platina.
    Acetis platini.

Acetite of lead.
    Acetis plumbi.
{ *Acetited lead.*
{ *Vinegar of faturn.*
{ *Salt* or *fugar of faturn.*

Acetite of potafh.
    Acetis potaffæ, vel *potaffeus.*
{ *Acetited potafh.*
{ *Terra foliata tartari.*

Acetite of foda.
    Acetis fodæ, vel *fodaceus.*
{ *Acetited foda.*
{ *Mineral acetous falt.*
{ *Terra foliata mineralis.*
{ *Cryftallizable terra foliata.*

Acetite of tungften.
    Acetis tunfteni.

Acetite of zinc.
    Acetis zinci.
{ *Acetited zinc.*
{ *Acetous falt of zinc.*

Acid, acetous.
    Acidum acetofum.
{ *Acetous acid.*
{ *Diftilled vinegar.*

Acid, acetic.
    Acidum aceticum.
{ *Radical vinegar.*
{ *Spirit of Venus.*

Acid, arfenic.
    Acidum arfenicum.
} *Arfenical acid.*

Acid, benzoic.
    Acidum benzoicum.
{ *Benzonic acid.*
{ *Acid of benzoin.*
{ *Salt of benzoin.*

Acid, fublimated benzoic.
    Acidum benzoicum fublimatum.
{ *Flowers of benzoin.*
{ *Volatile falt of benzoin.*

Acid, bombic.
    Acidum bombicum.
{ *Acid of the filk worm.*
{ *Bombycine acid.*

NEW NAMES.	A	OLD NAMES.

Acid, boracic.
   Acidum boracicum.

{ *Volatile narcotic salt of vitriol.*
Sedative salt.
Acid of borax.
Boracine acid.

Acid, carbonic.
   Acidum carbonicum.

{ *Gas sylvestre.*
Spiritus sylvestris.
Fixed air.
Aerial acid.
Atmospheric acid.
Mephitic acid.
Cretaceous acid.
Carbonaceous acid.

Acid, citric.
   Acidum citricum.

{ *Lemon juice.*
Citronian acid.

Acid, fluoric.
   Acidum fluoricum.

{ *Fluoric acid.*
Spathose acid.

Acid, formic.
   Acidum formicum.

{ *Acid of ants.*
Formicine acid.

Acid, gallic.
   Acidum gallæ, seu *gallaceum.*

{ *Astringent principle.*
Gallic acid.

Acid, lactic.
   Acidum lacticum.

{ *Sour whey.*
Galactic acid.

Acid, lithic.
   Acidum lithicum.

{ *Acid of the stone in the bladder.*
Bezoardic acid.
Lithiasic acid.

Acid, malic.
   Acidum malicum.

{ *Acid of apples.*
Malusian acid.

Acid, molybdic.
   Acidum molybdicum.

{ *Acid of molybdena.*
Molybdic acid.
Acid of Wolfram.

Acid, muriatic.
   Acidum muriaticum.

{ *Acid of marine salt.*
Fuming spirit of salt.
Marine acid.

Acid, oxigenated muriatic.
   Acidum muriaticum oxigenatum

{ *Dephlogisticated marine acid.*
Aerated marine acid.

Acid, nitrous.
   Acidum nitrosum.

{ *Ruddy nitrous acid.*
Phlogisticated nitrous acid.
Fuming nitrous acid.
Fuming spirit of nitre.

NEW NAMES.	A	OLD NAMES.

Acid, nitric.
  Acidum nitricum.
{ *White nitrous acid.*
Nitric acid without gas.
Dephlogisticated nitrous acid. }

Acid, nitro-muriatic.
  Acidum nitro-muriaticum.
{ *Aqua regia.*
Regaline acid. }

Acid, oxalic.
  Acidum oxalicum.
{ *Acid of sorrel.*
Oxaline acid.
Saccharine acid.
Acid of sugar. }

Acid, phosphorous.
  Acidum phosphorosum.
} *Volatile phosphoric acid.*

Acid, phosphoric.
  Acidum phosphoricum.
{ *Phosphoric acid.*
Acid of urine. }

Acid, prussic.
  Acidum prussicum.
} *Colouring matter of Prussian blue.*

Acid, pyro-ligneous.
  Acidum pyro-lignosum.
} *Empyreumatic acid spirit of wood.*

Acid, pyro-mucous.
  Acidum pyro-mucosum.
{ *Spirit of honey, sugar,* &c.
Syrupous acid. }

Acid, pyro-tartarous.
  Acidum pyro-tartarosum.
} *Spirit of tartar.*

Acid, saccho-lactic.
  Acidum saccho-lacticum.
{ *Acid of sugar of milk.*
Saccho-lactic acid. }

Acid, sebacic.
  Acidum sebacicum.
{ *Sebaceous acid.*
Acid of tallow. }

Acid, succinic.
  Acidum succinicum.
{ *Acid of amber.*
Volatile salt of amber. }

Acid, sulphureous.
  Acidum sulphurosum.
{ *Sulphureous acid.*
Volatile sulphureous acid.
Phlogisticated vitriolic acid.
Spirit of sulphur. }

Acid, sulphuric.
  Acidum sulphuricum.
{ *Acid of sulphur.*
Vitriolic acid.
Oil of vitriol.
Spirit of vitriol. }

Acid, tartareous.
  Acidum tartarosum.
{ *Tartareous acid.*
Acid of tartar. }

New Names.	A	Old Names.

Acid, tunftic.
   Acidum tunſticum.
                  { *Tungstic acid.*
                  Acid of tungsten.
                  Acid of Wolfram.

Affinity.
   Affinitas.   } *Affinity.*

Aggregation.
   Aggregatio.   } *Aggregation.*

Aggregates.
   Aggregata.   } *Aggregates.*

Atmofpheric air.
   Aer atmofphericus.   } *Atmoſpheric air.*

Alkalis.
   Alkalia.   } *Alkalis in general.*

Alcohol.
   Alcohol, indecl.   { *Spirit of wine.*
                  Ardent ſpirit.

Alcohol of potafh.
   Alcohol potaſſæ.   { *Lilium of Paracelſus.*
                  Acrid tinЕture of tartar.

Alcohol, nitric.
   Alcohol nitricum.   } *Dulcified ſpirit of nitre.*

Alcohols, refinous.
   Alcohol reſinoſa.   } *Spiritous tinЕtures.*

Alloy.
   Connubium metallicum. } *Alloy of metals.*

Alumina.
   Alumina.   { *Earth of alum.*
                  Baſe of alum.
                  Pure clay.

Amalgam.   *Amalgam.*

Ammoniac.
   Ammoniaca.   { *Cauſtic volatile alkali.*
                  Fluor volatile alkali.
                  Volatile ſpirit of ſal ammoniac.

Antimony.
   Antimonium, ſtibium. } *Regulus of antimony.*

Aroma.
   Aroma.   { *Spiritus rector.*
                  Odorate principle.

Arfeniates.
   Arſenias, tis. ſ. m. } *Arſenical ſalts.*

Acidulous arſeniate of potaſh.
   Arſenias acidulus potaſſæ. } *Macquer's arſenical neutral ſalt.*

Arſeniate of alumina.
   Arſenias aluminæ.

Arſeniate of ammoniac.
   Arſenias ammoniacæ, ſeu
      ammoniacalis. } *Arſenical ammoniac.*

Arſeniate of ſilver.
   Arſenias argenti.

Arſeniate of baryta.
   Arſenias barytæ.

Arſeniate of biſmuth.
   Arſenias biſmuthi.

Arſeniate of lime.
   Arſenias calcis.

Arſeniate of cobalt.
   Arſenias cobalti.

Arſeniate of copper.
   Arſenias cupri.

Arſeniate of tin.
   Arſenias ſtanni.

Arſeniate of iron.
   Arſenias ferri.

Arſeniate of magneſia.
   Arſenias magneſiæ.

Arſeniate of manganeſe.
   Arſenias magneſii.

Arſeniate of mercury.
   Arſenias hydrargyri.

Arſeniate of molybdena.
   Arſenias molybdeni.

Arſeniate of nickel.
   Arſenias niccoli.

Arſeniate of gold.
   Arſenias auri.

Arſeniate of platina.
   Arſenias platini.

Arſeniate of lead.
  Arſenias plumbi.

Arſeniate of potaſh.
  Arſenias potaſſæ.

Arſeniate of ſoda.
  Arſenias ſodæ.

Arſeniate of tungſten.
  Arſenias tunſteni.

Arſeniate of zinc.
  Arſenias zinci.

Azote.   *Baſe of atmoſpheric mephitiſe.*

B

Barytes, *or* baryta. $\Big\{$ *Terra ponderoſa.*
  Baryta.   *Earth of ponderous ſpar.*
                              Barotes.

Balſams. $\Big\}$ *Balſams of Bucquet.* *
  Balſama.

Benzoin. $\Big\}$ *Benzoin.*
  Benzoe.

                            Benzone.

Benzoate.   A ſalt formed by the union
  Benzoas, tis. ſ. m.   of the benzoic acid with differ-
                            ent bafes.
                               Salts of this kind have no
                            names in the old Nomencla-
                            ture.

Benzoate of alumina.
  Benzoas aluminoſus.

Benzoate of ammoniac.
  Benzoas ammoniacalis.

Benzoate of antimony.
  Benzoas ſtibii.

  * Reſins combined with a concrete acid ſalt.

Benzoate of filver.
Benzoas argenti.

Benzoate of arfenic.
Benzoas arfenicalis.

Benzoate of barytes.
Benzoas baryticus.

Benzoate of bifmuth.
Benzoas bifmuthi.

Benzoate of lime.
Benzoas calcareus.

Benzoate of cobalt.
Benzoas cobalti.

Benzoate of copper.
Benzoas cupri.

Benzoate of tin.
Benzoas ftanni.

Benzoate of iron.
Benzoas ferri.

Benzoate of magnefia.
Benzoas magnêfiæ.

Benzoate of manganefe.
Benzoas magnefii.

Benzoate of mercury.
Benzoas hydrargyri.

Benzoate of molybdena.
Benzoas molybdeni.

Benzoate of nickel.
Benzoas niccoli.

Benzoate of gold.
Benzoas auri.

Benzoate of platina.
Benzoas platini.

Benzoate of lead.
Benzoas plumbi.

Benzoate of potafh.
Benzoas potaffæ.

Benzoate of foda.
  Benzoas fodæ.

Benzoate of tungften.
  Benzoas tunfteni.

Benzoate of zinc.
  Benzoas zinci.

Bifmuth.
  Bifmuthum.

} Bifmuth.

Bitumens.
  Bitumina.

} Bitumens.

Bombiate.
  Bombias, tis. f. m.

Salts formed by the union of the bombic acid with different bafes.
  This genus of falts had no name in the old Nomenclature.

Bombiate of alumina.
  Bombias aluminofus.

Bombiate of ammoniac.
  Bombias ammoniacalis.

Bombiate of antimony.
  Bombias ftibii.

Bombiate of filver.
  Bombias argenti.

Bombiate of arfenic.
  Bombias arfenicalis.

Bombiate of barytes.
  Bombias baryticus.

Bombiate of bifmuth.
  Bombias bifmuthi.

Bombiate of lime.
  Bombias calcareus.

Bombiate of cobalt.
  Bombias cobalti.

Bombiate of copper.
  Bombias cupri.

Bombiate of tin.
  Bombias ftanni.

Bombiate of iron.
  Bombias ferri.
Bombiate of magnefia.
  Bombias magnefiæ.
Bombiate of manganefe.
  Bombias magnefii.
Bombiate of mercury.
  Bombias hydrargyri.
Bombiate of molybdena.
  Bombias molybdeni.
Bombiate of nickel.
  Bombias niccoli.
Bombiate of gold.
  Bombias auri.
Bombiate of platina.
  Bombias platini.
Bombiate of lead.
  Bombias plumbi.
Bombiate of potafh.
  Bombias potaffæ.
Bombiate of foda.
  Bombias fodæ.
Bombiate of tungften.
  Bombias tunfteni.
Bombiate of zinc.
  Bombias zinci.
Borate.
  Boras, tis. f. m. } *Borax.*
Borate, aluminous.
  Boras aluminofus. } *Argillaceous borax.*
Borate, ammoniacal.
  Boras ammoniacalis. { *Ammoniacal borax.*
                         { *Sedative fal ammoniac.*
Borate of antimony.
  Boras ftibii. } *Borax of antimony.*
Borate of filver.
  Boras argenti.

3 C 2

Borate of arfenic.
  Boras arfenici.

Borate of barytes, *or* baryta. } *Ponderous* or *barotic borax.*
  Boras barytæ.

Borate of bifmuth.
  Boras bifmuthi.

Borate of lime.
  Boras calcis.

Borate of cobalt. } *Borax of cobalt.*
  Boras cobalti.

Borate of copper. } *Borax of copper.*
  Boras cupri.

Borate of tin.
  Boras ftanni.

Borate of iron. } *Borax of iron.*
  Boras ferri.

Borate of magnefia. } *Magnefian borax.*
  Boras magnefiæ.

Borate of manganefe.
  Boras magnefii.

Borate of mercury. { *Mercurial borax.*
  Boras mercurii.   { *Mercurial fedative falt.*

Borate of molybdena.
  Boras molybdeni.

Borate of nickel.
  Boras niccoli.

Borate of gold.
  Boras auri.

Borate of platina.
  Boras platini.

Borate of lead.
  Boras plumbi.

Borate of potafh. } *Vegetable borax.*
  Boras potaffæ.

Borate of foda. { *Common borax faturated with bo-*
  Boras fodæ.   { *racic acid.*

| New Names. | B | Old Names. |

Borate of tungsten.
  Boras tunsteni.

Borate of zinc.
  Boras zinci.   } *Borax of zinc.*

Borate of soda, *or* borate
  supersaturated with soda.
{ *Crude borax.*
  Tinckal.
  Chrysocolla.
  Borax of commerce.

C

Caloric.
  Caloricum.
{ *Latent heat.*
  Fixed heat.
  Principle of heat.

Camphor.
  Camphora.   } *Camphor.*

Camphorate.
  Camphoras, tis. s. m.
{   A salt formed by the combin-
  ation of camphoric acid with
  different bases.
    These salts were not known
  formerly ; and accordingly, they
  have no names in the old No-
  menclature.

Camphorate of alumina.
  Camphoras aluminosus.

Camphorate of ammoniac.
  Camphoras ammoniacalis.

Camphorate of antimony.
  Camphoras stibii.

Camphorate of silver.
  Camphoras argenti.

Camphorate of arsenic.
  Camphoras arsenicalis.

Camphorate of barytes.
  Camphoras baryticus.

Camphorate of bifmuth.
  Camphoras bifmuthi.
Camphorate of lime.
  Camphoras calcareus.
Camphorate of cobalt.
  Camphoras cobalti.
Camphorate of copper.
  Camphoras cupri.
Camphorate of tin.
  Camphoras ftanni.
Camphorate of iron.
  Camphoras ferri.
Camphorate of magnefia.
  Camphoras magnefiæ.
Camphorate of manganefe.
  Camphoras magnefii.
Camphorate of mercury.
  Camphoras mercurii.
Camphorate of molybdena.
  Camphoras molybdeni.
Camphorate of nickel.
  Camphoras niccoli.
Camphorate of gold.
  Camphoras auri.
Camphorate of platina.
  Camphoras platini.
Camphorate of lead.
  Camphoras plumbi.
Camphorate of potafh.
  Camphoras potaffæ.
Camphorate of foda.
  Camphoras fodæ.
Camphorate of tungften.
  Camphoras tunfteni.
Camphorate of zinc.
  Camphoras zinci.

| OLD NAMES. | C | NEW NAMES. |

Carbone.
   Carbonicum.
} *Pure coal.*

Carbonate.
   Carbonas, tis, f. m.
{ A falt formed by the union of carbonic acid with different bafes.

Carbonate of alumina.
   Carbonas aluminofus.
} *Cretaceous clay.*

Carbonate, ammoniacal.
   Carbonas ammoniacæ.
{ *Ammoniacal chalk.*
Cretaceous ammoniacal falt.
Concrete volatile alkali.
Ammoniacal mephite.
Englifh fal volatile.

Carbonate of antimony.
   Carbonas antimonii.

Carbonate of filver.
   Carbonas argenti.

Carbonate of arfenic.
   Carbonas arfenici.

Carbonate of barytes.
   Carbonas baryticus.
{ *Barotic* or *ponderous chalk.*
Aerated ponderous earth.
Effervefcent barotes.
Barotic mephite.

Carbonate of bifmuth.
   Carbonas bifmuthi.

Calcareous carbonate.
   Carbonas calcareus.
{ *Chalk.*
Limeftone.
Calcareous mephite.
Aerated calcareous earth.
Effervefcent calcareous earth.
Calcareous fpar.
Cream of lime.

Carbonate of cobalt.
   Carbonas cobalti.

Carbonate of copper.
   Carbonas cupri.

Carbonate of tin.
   Carbonas ftanni.

NEW NAMES.	OLD NAMES.
Carbonate of iron. *Carbonas ferri.*	*Aperient saffron of mars. Ruft of iron. Aerated iron. Martial chalk. Martial mephite.*
Carbonate of magnefia. *Carbonas magnefiæ.*	*Magnefian earth. White Magnefia. Aerated magnefia of Bergman. Cretaceous magnefia. Magnefian chalk. Effervefcent magnefia. Mephite of magnefia. Kirwan's muriatic earth. Powder of Count Palma, and of Sentinelli.*
Carbonate of manganefe. *Carbonas magnefii.*	
Carbonate of mercury. *Carbonas hydrargyri.*	
Carbonate of molybdena. *Carbonas molybdeni.*	
Carbonate of nickel. *Carbonas niccoli.*	
Carbonate of gold. *Carbonas auri.*	
Carbonate of platina. *Carbonas platini.*	
Carbonate of lead. *Carbonas plumbi.*	*Chalk of lead. Spathofe lead. Mephite of lead.*
Carbonate of potafh. *Carbonas potaffæ.*	*Fixed falt of tartar. Vegetable fixed alkali. Aerated vegetable fixed alkali. Cretaceous tartar. Mephitic tartar. Mephite of potafh. Nitre fixed by itfelf. Alkaheft of Van Helmont.*

Carbonate of soda.
  Carbonas sodæ.
$\left\{\begin{array}{l}\text{Natrum or Natron.}\\ \text{Base of marine salt.}\\ \text{Marine or mineral alkali.}\\ \text{Crystals of soda.}\\ \text{Cretaceous soda.}\\ \text{Aerated soda.}\\ \text{Effervescent soda.}\\ \text{Mephite of soda.}\\ \text{Aerated mineral fixed alkali.}\\ \text{Effervescent mineral fixed alkali.}\\ \text{Chalk of soda.}\end{array}\right.$

Natrum or Natron.
Base of marine salt.
Marine or mineral alkali.
Crystals of soda.
Cretaceous soda.
Aerated soda.
Effervescent soda.
Mephite of soda.
Aerated mineral fixed alkali.
Effervescent mineral fixed alkali.
Chalk of soda.

Carbonate of tungsten.
  Carbonas tunsteni.

Carbonate of zinc.
  Carbonas zinci.
Chalk of zinc.
Aerated zinc.
Mephite of zinc.

Carbure of iron.
Plumbago.

Calcareous earth or lime, diluted in water.
Milk of lime.

Calcareous earth or lime.
Calcareous earth.
Quicklime.

Citrate.
  Citras, tis, f. m.
    A salt formed by the combination of the acid of citrons with different bases.
    This salt had no name in the old nomenclature.

Citrate of alumina.
  Citras aluminosus.

Citrate of ammoniac.
  Citras ammoniacalis.

Citrate of antimony.
  Citras stibii.

Citrate of silver.
  Citras argenti.

Citrate of arsenic.
  Citras arsenicalis.

Citrate of barytes.
  Citras baryticus.

Citrate of bifmuth.
   Citras bifmuthi.
Citrate of lime.
   Citras calcareus.
Citrate of cobalt.
   Citras cobalti.
Citrate of copper.
   Citras cupri.
Citrate of tin.
   Citras ftanni.
Citrate of iron.
   Citras ferri.
Citrate of magnefia.
   Citras magnefiæ.
Citrate of manganefe.
   Citras magnefii.
Citrate of mercury.
   Citras mercurii.
Citrate of molybdena.
   Citras molybdeni.
Citrate of nickel.
   Citras niccoli.
Citrate of gold.
   Citras auri.
Citrate of platina.
   Citras platini.
Citrate of lead.
   Citras plumbi.
Citrate of potafh.
   Citras potaffæ.
Citrate of foda.
   Citras fodæ.
Citrate of tungften.
   Citras tunfteni.
Citrate of zinc.
   Citras zinci.

NEW NAMES.	C	OLD NAMES.

Clay, a mixture of aluminous and filiceous earths, *argilla.*
{ *Clay.*
Potter's earth.
Argillaceous earth. }

Cobalt.
{ *Regulus of Cobalt.*
Cobalt, or *cobolt.* }

Copper.
Cuprum.
{ *Copper.*
Venus. }

D

Diamond.   *Diamond.*

E

Ether, acetic.
Ether aceticum. } *Acetous ether.*

Ether, muriatic.
Ether muriaticum. } *Marine ether.*

Ether, nitric.
Ether nitricum. } *Nitrous ether.*

Ether fulphuric.
Ether fulphuricum. } *Vitriolic ether.*

Extractive principle.
Extractum. } *Extract.*

F

Fecula.
Fecula. } *Fecula of plants.*

Fluate.
Fluas, tis. f. m.
{ A falt formed by the combination of the fluoric acid with different bafes. }

Fluate of alumina.
Fluas aluminæ.
{ *Argillaceous fluor.*
Spathofe clay. }

Fluate, ammoniacal. *Fluas ammoniacalis.*	⎧ *Ammoniacal sparry salt.* ⎨ *Sparry ammoniac.* ⎪ *Ammoniacal spar.* ⎩ *Ammoniacal fluor.*
Fluate of antimony. *Fluas stibii.*	
Fluate of silver. *Fluas argenti.*	
Fluate of arsenic. *Fluas arsenicalis.*	
Fluate of barytes. *Fluas barytæ.*	⎰ *Ponderous fluor.* ⎱ *Barotic fluor.*
Fluate of bismuth. *Fluas bismuthi.*	
Fluate of lime. *Fluas calcareus.*	⎧ *Fluor spar.* ⎪ *Vitreous spar.* ⎨ *Cubic spar.* ⎪ *Phosphoric spar.* ⎩ *Sparry fluor.*
Fluate of cobalt. *Fluas cobalti.*	
Fluate of copper. *Fluas cupri.*	
Fluate of tin. *Fluas stanni.*	
Fluate of iron. *Fluas ferri.*	
Fluate of magnesia. *Fluas magnesiæ.*	⎧ *Fluorated magnesia.* ⎨ *Sparry magnesia.* ⎩ *Magnesian fluor.*
Fluate of manganese. *Fluas magnesii.*	
Fluate of mercury. *Fluas mercurii.*	
Fluate of molybdena. *Fluas molybdeni.*	
Fluate of nickel. *Fluas niccoli.*	

F

Fluate of gold.
  Fluas auri.
Fluate of platina.
  Fluas platini.
Fluate of lead.
  Fluas plumbi.
Fluate of potaſh.   { *Tartareous fluor.*
  Fluas potaſſæ.   { *Sparry tartar.*
Fluate of ſoda.   .   { *Fluor of ſoda.*
  Fluas ſodæ.   { *Sparry ſoda.*
Fluate of tungſten.
  Fluas tunſteni.
Fluate of zinc.
  Fluas zinci.

Formiate.   {   Salt formed by the combina-
  Formias, tis, ſ. m.   tion of the formic acid with dif-
                           ferent baſes.
                           {   This genus of ſalt has no
                           name in the old nomenclature.

Formiate of alumina.
  Formias aluminoſus.
Formiate of ammoniac.
  Formias ammoniacalis.
Formiate of antimony.
  Formias ſtibii.
Formiate of ſilver.
  · *Formias argenti.*
Formiate of arſenic.
  Formias arſenicalis.
Formiate of barytes.
  Formias baryticus.
Formiate of biſmuth.
  Formias biſmuthi.
Formiate of lime.
  Formias calcareus.

F

Formiate of cobalt.
Formias cobalti.

Formiate of copper.
Formias cupri.

Formiate of tin.
Formias stanni.

Formiate of iron.
Formias ferri.

Formiate of magnesia.
Formias magnesiæ.

Formiate of manganese.
Formias magnesii.

Formiate of mercury.
Formias mercurii.

Formiate of molybdena.
Formias molybdeni.

Formiate of nickel.
Formias niccoli.

Formiate of gold.
Formias auri.

Formiate of platina.
Formias platini.

Formiate of lead.
Formias plumbi.

Formiate of potash.
Formias potassæ.

Formiate of soda.
Formias sodæ.

Formiate of tungsten.
Formias tunsteni.

Formiate of zinc.
Formias zinci.

NEW NAMES.	OLD NAMES.

G

Gas. *Gas.*	{ *Gas.* *Elastic fluids.* *Aeriform fluids.*
Gas, acetous acid. *Gas acidum acetosum.*	} *Acetous acid gas.*
Gas, carbonic acid. *Gas acidum carbonicum.*	{ *Fixed air.* *Solid air of Hales.* *Cretaceous acid gas.* *Mephitic gas.* *Aerial acid.*
Gas, fluoric acid. *Gas acidum fluoricum.*	{ *Sparry acid gas.* *Fluoric acid gas.*
Gas, muriatic acid. *Gas acidum muriaticum.*	{ *Marine air.* *Marine acid gas.* *Muriatic acid gas.*
Gas, oxigenated muriatic acid. *Gas acidum muriaticum oxigenatum.*	} *Aerated muriatic acid gas.* *Dephlogisticated marine acid.*
Gas, nitrous acid. *Gas acidum nitrosum.*	} *Nitrous acid gas.*
Gas, prussic acid. *Gas acidum prussicum.*	} *Prussian gas.*
Gas, sulphureous acid. *Gas acidum sulphureum.*	{ *Sulphureous acid gas.* *Vitriolic acid air.*
Gas, ammoniacal. *Gas ammoniacale.*	{ *Alkaline gas.* *Alkaline air.* *Volatile alkaline gas.*
Gas, azotic. *Gas azoticum.*	{ *Vitiated air.* *Impure air.* *Phlogisticated air.* *Phlogisticated gas.* *Atmospheric mephitis.*
Gas, hydrogenous. *Gas hydrogenium.*	{ *Inflammable gas.* *Inflammable air.* *Phlogiston of Mr Kirwan.*

Gas, carbonated hydrogenous. } *Carbonaceous inflammable gas.*
    Gas hydrogenium carbonatum.

Gas, hydrogenous, of marshes. { *Mephitized inflammable gas.*
    Gas hydrogenium paludum.   { *Inflammable gas of marshes.*

Gas, phosphorized hydrogen-
    ous.   } *Phosphoric gas.*
Gas hydrogenium phosphorisatum.

Gas, sulphurated hydrogenous. } *Hepatic gas.*
    Gas hydrogenium sulphuratum.

Gas, nitrous.   } *Nitrous gas.*
    Gas nitrosum.

Gas, oxigenous.   { *Vital air.*
    Gas oxigenium.   { *Pure air.*
                                 { *Dephlogisticated air.*

Gluten, *or* the glutinous   } *Gluten of flour of wheat.*
    principle.   { *Vegeto-animal matter.*
        Gluten.

Gold.   } *Gold.*
    Aurum.

I

Iron.   } *Iron.*
    Ferrum.

L.

Lactate.   { Salts formed by the union
    Lactas, tis. f. m.   of the acid of sour whey, or the
                                  lactic acid, with different bases.
                                     These salts were not known
                                  before Scheele ; and their pro-
                                  perties being as yet but little
                                  examined, they have hitherto
                                  received no name.

Lactate of alumina.
  Lactas aluminosus.

Lactate of ammoniac.
  Lactas ammoniacalis.

Lactate of antimony.
  Lactas stibii.

Lactate of silver.
  Lactas argenti.

Lactate of arsenic.
  Lactas arsenicalis.

Lactate of barytes.
  Lactas baryticus.

Lactate of bismuth.
  Lactas bismuthi.

Lactate of lime.
  Lactas calcareus.

Lactate of cobalt.
  Lactas cobalti.

Lactate of copper.
  Lactas cupri.

Lactate of tin.
  Lactas stanni.

Lactate of iron.
  Lactas ferri.

Lactate of magnesia.
  Lactas magnesiæ.

Lactate of manganese.
  Lactas magnesii.

Lactate of mercury.
  Lactas hydrargyri.

Lactate of molybdena.
  Lactas molybdeni.

Lactate of nickel.
  Lactas niccoli.

Lactate of gold.
  Lactas auri.

Lactate of platina.
  Lactas platini.

Lactate of lead.
  Lactas plumbi.

Lactate of potash.
  Lactas potassæ.

Lactate of soda.
  Lactas sodæ.

Lactate of tungsten.
  Lactas tunsteni.

Lactate of zinc.
  Lactas zinci.

Lead.   { *Lead.*
  Plumbum.   { *Saturn.*

Light.   *Light.*

                         ⌠ Salts formed by the union of
                         │ the lithic acid, or stone in the
                         │ bladder, with different bases.
Lithiate.   ⎨   These salts are not compre-
  Lithias, tis. s. m. │ hended in the ancient Nomen-
                         │ clature, being unknown before
                         ⌡ Scheele.

Lithiate of alumina.
  Lithias aluminosus.

Lithiate of ammoniac.
  Lithias ammoniacalis.

Lithiate of antimony.
  Lithias stibii.

Lithiate of silver.
  Lithias argenti.

Lithiate of arsenic.
  Lithias arsenicalis.

Lithiate of barytes.
  Lithias baryticus.

Lithiate of bismuth.
  Lithias bismuthi.

Lithiate of lime.
  Lithias calcareus.

Lithiate of cobalt.
   Lithias cobalti.

Lithiate of copper.
   Lithias cupri.

Lithiate of tin.
   Lithias stanni.

Lithiate of iron.
   Lithias ferri.

Lithiate of magnesia.
   Lithias magnesiæ.

Lithiate of manganese.
   Lithias magnesii.

Lithiate of mercury.
   Lithias hydrargyri.

Lithiate of molybdena.
   Lithias molybdeni.

Lithiate of nickel.
   Lithias niccoli.

Lithiate of gold.
   Lithias auri.

Lithiate of platina.
   Lithias platini.

Lithiate of lead.
   Lithias plumbi.

Lithiate of potash.
   Lithias potassæ.

Lithiate of soda.
   Lithias sodæ.

Lithiate of tungsten.
   Lithias tunsteni.

Lithiate of zinc.
   Lithias zinci.

M

Malate.
   Malas, tis. f. m.

Salt formed by the union of the malic acid, or acid of apples, with different bases.

This genus of salt has not yet obtained a name in the old Nomenclature.

Malate of alumina.
Malas aluminofus.

Malate of ammoniac.
Malas ammoniacalis.

Malate of antimony.
Malas ftibii.

Malate of filver.
Malas argenti.

Malate of arfenic.
Malas arfenicalis.

Malate of barytes.
Malas baryticus.

Malate of bifmuth.
Malas bifmuthi.

Malate of lime.
Malas calcareus.

Malate of cobalt.
Malas cobalti.

Malate of copper.
Malas cupri.

Malate of tin.
Malas ftanni.

Malate of iron.
Malas ferri.

Malate of magnefia.
Malas magnefiæ.

Malate of manganefe.
Malas magnefii.

Malate of mercury.
Malas hydrargyri.

Malate of molybdena.
Malas molybdeni.

Malate of nickel.
Malas niccoli.

Malate of gold.
Malas auri.

Malate of platina.
Malas platini.

Malate of lead.
Malas plumbi.

Malate of potaſh.
Malas potaſſæ.

Malate of ſoda.
Malas ſodæ.

Malate of tungſten.
Malas tunſteni.

Malate of zinc.
Malas zinci.

Manganeſe. } *Regulus of manganeſe.*
Magneſium.

Mercury. { *Mercury.*
Hydrargyrum. { *Quickſilver.*

Molybdate. Salt formed by the union of
Molybdas, tis, ſ. m. the molybdic acid with different
baſes. –
This genus of ſalts had no
name in the old Nomenclature.

Molybdate of alumina.
Molybdas aluminoſus.

Molybdate of ammoniac.
Molybdas ammoniacalis.

Molybdate of antimony.
Molybdas ſtibii.

Molybdate of ſilver.
Molybdas argenti.

Molybdate of arſenic.
Molybdas arſenicalis.

Molybdate of barytes.
Molybdas baryticus.

Molybdate of biſmuth.
Molybdas biſmuthi.

Molybdate of lime.
Molybdas calcareus.

Molybdate of cobalt.
Molybdas cobalti.

Molybdate of copper.
Molybdas cupri.

Molybdate of tin.
   Molybdas ftanni.

Molybdate of iron.
   Molybdas ferri.

Molybdate of magnefia.
   Molybdas magnefiæ.

Molybdate of manganefe.
   Molybdas magnefii.

Molybdate of mercury.
   Molybdas hydrargyri.

Molybdate of nickel.
   Molybdas niccoli.

Molybdate of gold.
   Molybdas auri.

Molybdate of platina.
   Molybdas platini.

Molybdate of lead.
   Molybdas plumbi.

Molybdate of potafh.
   Molybdas potaffæ.

Molybdate of foda.
   Molybdas fodæ.

Molybdate of tungften.
   Molybdas tunfteni.

Molybdate of zinc.
   Molybdas zinci.

Molybdena.   *Regulus of molybdena.*

Mucus.   *Mucilage.*

Muriate.   { Salt formed by the union of the
   Murias, tis. f. m.   { muriatic acid with different bafes.

Muriate of alumina.   { *Marine alum.*
   Murias aluminofus.   { *Argillaceous marine falt.*

Muriate of ammoniac.   { *Sal ammoniac.*
   Murias ammoniacalis.   { *Salmiac.*

Muriate of antimony.   } *Muriate of antimony.*
   Murias ftibii.

Muriate, fuming, of antimony. } *Butter of antimony.*
Murias ftibii fumans.

Muriate of filver. { *Corneous filver.*
Murias argenti. { *Corneous luna.*

Muriate of arfenic.
Murias arfenicalis.

Muriate, fublimated, of arfenic. } *Butter of arfenic.*
Murias arfenicalis fublimatus.

Muriate of barytes. } *Barotic marine falt.*
Murias baryticus.

Muriate of bifmuth. } *Muriate of bifmuth.*
Murias bifmuthi.

Muriate, fublimated, of bif-
    muth. } *Butter of bifmuth.*
Murias bifmuthi fublimatus.

Muriate of lime. { *Mother water of marine falt.*
Murias calcareus. { *Calcareous marine falt.*
                     { *Fixed fal ammoniac.*

Muriate of cobalt. } *Ink of fympathy.*
Murias cobalti.

Muriate of copper. } *Muriate of copper.*
Murias cupri.

Muriate, fublimated ammo-
    niacal, of copper.
    Murias cupri ammonia- } *Cupreous ammoniacal flowers.*
    calis fublimatus.

Muriate of tin. } *Salt of Jupiter.*
Murias ftanni.

Muriate, concrete, of tin. { *Solid butter of tin of M. Baumé.*
Murias ftanni concretus. { *Corneous tin.*

Muriate, fuming, of tin. } *Fuming liquor of Libavius.*
Murias ftanni fumans.

Muriate, fublimated, of tin. } *Butter of tin.*
Murias ftanni fublimatus.

Muriate of iron. } *Muriate of iron.*
Murias ferri. } *Marine falt of iron.*

3 D 4

New Names.	M	Old Names.

Muriate, sublimated ammo-
    niacal, of iron.
        Murias ferri ammonia-
        calis sublimatus.
} *Martial ammoniacal flowers.*

Muriate of magnesia.
    Murias magnesiæ.
} *Marine salt with a base of mag-*
    nesia.

Muriate of manganese.
    Murias magnesii.
} *Muriate of manganese.*

Muriate, corrosive, of mercury.
    Murias hydrargyri corrosivus.
} *Corrosive sublimate.*

Muriate, sweet, of mercury.
    Murias hydrargyri dulcis.
} *Sweet sublimate.*

Muriate, sweet sublimated,
    of mercury.
    Murias hydrargyri sublimatus.
} *Aquila alba.*

Muriate of mercury and am-
    moniac.
        Murias hydrargyri et am-
        moniacalis.
} *Sal alembroth.*

Muriate of mercury by pre-
    cipitation.
    Murias hydrargyri præcipitatus.
} *Salt of wisdom.*
    White precipitated muriate.

Muriate of molybdena.
    Murias molybdeni.

Muriate of nickel.
    Murias niccoli.

Muriate of gold.
    Murias auri.
{ *Muriate of gold.*
{ *Regaline salt of gold.*

Muriate of platina.
    Murias platini.
{ *Muriate of platina.*
{ *Regaline salt of platina.*

Muriate of lead.
    Murias plumbi.
{ *Corneous lead.*
{ *Muriate of lead.*

Muriate of potash.
    Murias potassæ.
} *Febrifuge salt of Sylvius.*

Muriate of soda.
    Murias sodæ.
} *Marine salt.*

NEW NAMES.	M	OLD NAMES.

Muriate, foffil, of foda.
   Murias fodæ foffilis. } *Sal gem.*

Muriate of tungften.
   Murias tunfleni.

Muriate of zinc.
   Murias zinci. { *Marine falt of zinc.*
              Muriate of zinc.

Muriate, fublimated, of zinc. }
   Murias zinci fublimatus. } *Butter of zinc.*

Muriates, oxigenated. { New combinations of the oxigenated muriatic acid with potafh and foda, difcovered by M. Berthollet.

Muriate, oxigenated, of potafh.
   Murias oxigenatus potaffæ.

Muriate, oxigenated, of foda.
   Murias oxigenatus fodæ.

N

Nitrate.
   Nitras, tis. f. m. { Salts formed by the combination of the nitric acid with different bafes.

Nitrate of alumina.
   Nitras aluminofus. { *Nitrous alum.*
              Argillaceous nitre.

Nitrate of ammoniac.
   Nitras ammoniacalis. { *Ammoniacal nitrous falt.*
              Ammoniacal nitre.

Nitrate of antimony.
   Nitras ftibii.

Nitrate of filver.
   Nitras argenti. { *Lunar nitre.*
              Nitre of filver.
              Cryftals of the moon

Nitrate, melted, of filver.
   Nitras argenti fufus. } *Infernal ftone.*

Nitrate of arfenic.
   Nitras arfenicalis. } *Nitre of arfenic.*

New Names	Old Names
Nitrate of barytes. *Nitras baryticus.*	{ *Nitre of ponderous earth.* *Barotic nitre.*
Nitrate of bifmuth. *Nitras bifmuthi.*	} *Nitre of bifmuth.*
Nitrate of lime. *Nitras calcareus.*	{ *Calcareous nitre.* *Mother water of nitre.*
Nitrate of cobalt. *Nitras cobalti.*	} *Nitre of cobalt.*
Nitrate of copper. *Nitras cupri.*	} *Nitre of copper.*
Nitrate of tin. *Nitras ftanni.*	{ *Nitre of tin.* *Stanno-nitrous falt.*
Nitrate of iron. *Nitras ferri.*	{ *Nitre of iron.* *Martial nitre.*
Nitrate of magnefia. *Nitras magnefiæ.*	{ *Nitre of magnefia.* *Magnefian nitre.*
Nitrate of manganefe. *Nitras magnefii.*	} *Nitre of manganefe.*
Nitrate of mercury. *Nitras hydrargyri.*	{ *Mercurial nitre.* *Nitre of mercury.*
Nitrate of mercury in a ftate of folution. *Nitras hydrargyri folutus.*	} *Mercurial water.*
Nitrate of molybdena. *Nitras molybdeni.*	
Nitrate of nickel. *Nitras niccoli.*	} *Nitre of nickel.*
Nitrate of gold. *Nitras auri.*	
Nitrate of platina. *Nitras platini.*	
Nitrate of lead. *Nitras plumbi.*	{ *Nitre of lead.* *Saturnine nitre.*
Nitrate of potafh, *or* nitre. *Nitras potaffæ,* vel *nitrum.*	{ *Nitre.* *Saltpetre.*

NEW NAMES.	N	OLD NAMES.

Nitrate of foda.
 Nitras fodæ.

{ *Cubic nitre.*
{ *Rhomboidal nitre.*

Nitrate of tungften.
 Nitras tunfteni.

Nitrate of zinc.
 Nitras zinci.

} *Nitre of zinc.*

Nitrite.
 Nitris, tis. f. m.

{ Salt formed by the combination of the *nitrous* * acid with different bafes.
 This genus of falts had no name in the old Nomenclature, being unknown before the late difcoveries.

Nitrite of alumina.
 Nitris aluminofus.

Nitrite of ammoniac.
 Nitris ammoniacalis.

Nitrite of antimony.
 Nitris ftibii.

Nitrite of filver.
 Nitris argenti.

Nitrite of arfenic.
 Nitris arfenicalis.

Nitrite of barytes.
 Nitris baryticus.

Nitrite of bifmuth.
 Nitris bifmuthi.

Nitrite of lime.
 Nitris calcareus.

Nitrite of cobalt.
 Nitris cobalti.

Nitrite of copper,
 Nitris cupri.

Nitrite of tin.
 Nitris ftanni,

---

 * That is, with fpirit of nitre containing lefs oxigene than *nitric* acid, which forms *nitrates.*

Nitrite of iron.
  Nitris ferri.

Nitrite of magnesia.
  Nitris magnesiæ.

Nitrite of manganese.
  Nitris magnesii.

Nitrite of mercury.
  Nitris hydrargyri.

Nitrite of molybdena.
  Nitris molybdeni.

Nitrite of nickel.
  Nitris niccoli.

Nitrite of gold.
  Nitris auri.

Nitrite of platina.
  Nitris platini.

Nitrite of lead.
  Nitris plumbi.

Nitrite of potash.
  Nitris potassæ.

Nitrite of soda.
  Nitris sodæ.

Nitrite of tungsten.
  Nitris tunsteni.

Nitrite of zinc.
  Nitris zinci.

O

Oils, empyreumatic.
  Olea empyreumatica.   } *Empyreumatic oils.*

Oils, fixed.
  Olea fixa.   { *Fat oils.*
                          Sweet oils.
                          Oils obtained by expression.

Oils, volatile.
  Olea volatilia.   { *Essential oils.*
                               Essences.

Oxalate.
    Oxalas, tis. f. m.
	Salt formed by the combination of the oxalic acid with different bafes.
	    Scarce any of the falts of this genus had a name in the old Nomenclature.

Oxalate, acidulous, of ammoniac.
    Oxalas acidulus ammoniacalis.

Oxalate, acidulous, of potafh. ⎱ *Salt of forrel of commerce.*
    Oxalas acidulus potaffæ. ⎰

Oxalate, acidulous, of foda.
    Oxalas acidulus fodæ.

Oxalate of alumina.
    Oxalas aluminofus.

Oxalate of ammoniac.
    Oxalas ammoniacalis.

Oxalate of antimony.
    Oxalas ftibii.

Oxalate of filver.
    Oxalas argenti.

Oxalate of arfenic.
    Oxalas arfenicalis.

Oxalate of barytes.
    Oxalas baryticus.

Oxalate of bifmuth.
    Oxalas bifmuthi.

Oxalate of lime.
    Oxalas calcareus.

Oxalate of cobalt.
    Oxalas cobalti.

Oxalate of copper.
    Oxalas cupri.

Oxalate of tin.
    Oxalas ftanni.

Oxalate of iron.
    Oxalas ferri.

Oxalate of magnefia.
    Oxalas magnefiæ.

Oxalate of manganese.
  Oxalas magnesii.

Oxalate of mercury.
  Oxalas hydrargyri.

Oxalate of molybdena.
  Oxalas molybdeni.

Oxalate of nickel.
  Oxalas niccoli.

Oxalate of gold.
  Oxalas auri.

Oxalate of platina.
  Oxalas platini.

Oxalate of lead.
  Oxalas plumbi.

Oxalate of potash.
  Oxalas potassæ.

Oxalate of soda.
  Oxalas sodæ.

Oxalate of tungsten.
  Oxalas tunsteni.

Oxalate of zinc.
  Oxalas zinci.

Oxide, arsenical, of potash.   } *Liver of arsenic.*
  Oxidum arsenicale potassæ.

Oxide, white, of arsenic.   { *White arsenic.*
  Oxidum arsenici album.   { *Lime of arsenic.*

Oxide of antimony, BY THE MU-
  RIATIC AND NITRIC ACIDS.   *Mineral bezoar.*
    Oxidum stibii acidis muria-
    tico et nitrico confectum.

Oxide of antimony, white, by   *Diaphoretic antimony.*
  nitre.   *Ceruse of antimony.*
    Oxidum stibii album nitro   *Materia perlata of Kerkringius.*
    confectum.

Oxide, white sublimated, of an-   *Snow of antimony.*
  timony.   *Flowers of antimony.*
    Oxidum stibii album sublima-   *Silver flowers of regulus of an-*
    tum.   *timony.*

NEW NAMES.	O	OLD NAMES.

Oxide of antimony, by the muriatic acid.
  Oxidum ſtibii acido muriatico confeƈtum.
} *Powder of Algaroth.*

Oxide, fulphurated, of antimony.
  Oxidum ſtibii fulphuratum.
} *Liver of antimony.*

Oxide, fulphurated femi-vitreous, of antimony.
  Oxidum ſtibii fulphuratum femi-vitreum.
} *Saffron of metals.*

Oxide, orange-coloured fulphurated, of antimony.
  Oxidum ſtibii fulphuratum aurantiacum.
} *Gilded ſulphur of antimony.*

Oxide, red fulphurated, of antimony.
  Oxidum ſtibii fulphuratum rubrum.
} *Kermes mineral.*

Oxide, vitreous fulphurated, of antimony.
  Oxidum ſtibii fulphuratum vitreum.
} *Glaſs of antimony.*

Oxide, brown vitreous fulphurated, of antimony.
  Oxidum ſtibii fulphuratum vitreum fuſcum.
} *Rubine of antimony.*

Oxide, white fublimated, of arfenic.
  Oxidum arſenici album fublimatum.
} *Flowers of arſenic.*

Oxide, yellow fulphurated, of arfenic.
  Oxidum arſenici fulphuratum luteum.
} *Orpiment.*

Oxide, red fulphurated, of arfenic.
  Oxidum arſenici fulphuratum rubrum.
} *Red arſenic.*
Realgar, or *realgal.*

Oxide, white, of bifmuth, by the nitrie acid.
Oxidum bifmuthi album acido nitrico confeĉtum.
  Magiftery of bifmuth.
  White paint.

Oxide, fublimated, of bifmuth.
Oxidum bifmuthi fublimatum.
  Flowers of bifmuth.

Oxide, grey, of cobalt with fi- lex, or zaffre.
Oxidum cobalti cinereum cum filice.
  Zaffre.

Oxide, vitreous, of cobalt.
Oxidum cobalti vitreum.
  Azure.
  Smalt.

Oxide, green, of copper.
Oxidum cupri viride.
  Verdigrife.
  Ruft of copper.

Oxide, grey, of tin.
Oxidum ftanni cinereum.
  Putty of tin.

Oxide, fublimated, of tin.
Oxidum ftanni fublimatum.
  Flowers of tin.

Oxides of iron.
Oxida ferri.
  Saffrons of Mars.

Oxide, brown, of iron.
Oxidum ferri fufcum.
  Aftringent faffron of Mars.

Oxide, yellow, of iron.
Oxidum ferri luteum.
  Ochre.

Oxide, blaek, of iron.
Oxidum ferri nigrum.
  Martial Ethiops.

Oxide, red, of iron.
Oxidum ferri rubrum.
  Colcothar.

Oxide, white, of manganefe.
Oxidum magnefii album.
  White calx of manganefe.

Oxide, black, of manganefe.
Oxidum magnefii nigrum.
  Black magnefia.
  Glafs-maker's foap.
  Stone of Perigueux.

Oxide, yellow, of mercury, by the nitric acid.
Oxidum hydrargyri luteum acido nitrico confeĉtum.
  Nitrous turbith.

| NEW NAMES. | O | OLD NAMES. |

Oxide, yellow, of mercury by the fulphuric acid.
    Oxidum hydrargyri luteum acido fulphurico confectum. } *Mineral turbith.*
Yellow precipitate.

Oxide, blackifh, of mercury.
    Oxidum hydrargyri nigrum. } *Ethiops* per fe.

Oxide, red, of mercury by the nitric acid.
    Oxidum hydrargyri rubrum acido nitrico confectum. } *Red precipitate.*

Oxide, red, of mercury by fire.
    Oxidum hydrargyri rubrum per ignem. } *Precipitate* per fe.

Oxide, black fulphurated, of mercury.
    Oxidum hydrargyri fulphuratum nigrum. } *Mineral ethiops.*

Oxide, red fulphurated, of mercury.
    Oxidum hydrargyri fulphuratum rubrum. } *Cinnabar.*

Oxide, ammoniacal, of gold.
    Oxidum auri ammoniacale. } *Fulminating gold.*

Oxide of gold by tin.
    Oxidum auri per ftannum. } *Precipitate of gold by tin.*
Purple of Caffius.

Oxides of lead.
    Oxida plumbi. } *Lime of lead.*

Oxide, white, of lead by the acetous acid.
    Oxidum plumbi album per acidum acetofum. } *White of lead.*

Oxide, femi-vitreous, of lead, or litharge.
    Oxidum plumbi femi-vitreum. } *Litharge.*

Oxide, yellow, of lead.
    Oxidum plumbi luteum. } *Mafficot.*

Oxide, red, of lead, *or* minium.
    Oxidum plumbi rubrum. } *Minium.*

Oxide, fublimated, of zinc.
  Oxidum zinci fublimatum.

{ *Philofophic wool.*
Philofophic cotton.
Flowers of zinc.
Pompholyx.

Oxides, metallic.
  Oxida metallica.

} *Metallic calces.*

Oxides, metallic fublimated.
  Oxida metallica fublimata.

} *Metallic flowers.*

Oxygene.
  Oxygenium.

{ *Oxygene.*
Bafe of vital air.
Acidifying principle.
Empyreal air.
Principium forbile.

P

Phofphate.
  Phofphas, tis. f. m.

{ Salt formed by the union of the phofphoric acid with different bafes.

Phofphate of alumina.
  Phofphas aluminofus.

Phofphate of ammoniac.
  Phofphas ammoniacalis.

} *Phofphoric ammoniac.*
Ammoniacal phofphate.

Phofphate of antimony.
  Phofphas ftibii.

Phofphate of filver.
  Phofphas argenti.

Phofphate of arfenic.
  Phofphas arfenicalis.

Phofphate of barytes.
  Phofphas baryticus.

Phofphate of bifmuth.
  Phofphas bifmuthi.

Phofphate, calcareous, or of lime.
  Phofphas calcareus.

} *Earth of bones.*
Calcareous phofphate.
Animal earth.

Phofphate of cobalt.
　Phofphas cobalti.

Phofphate of copper.
　Phofphas cupri.

Phofphate of tin.
　Phofphas ftanni.

Phofphate of iron.　　　　　{ *Syderite.*
　Phofphas ferri.　　　　　{ *Iron of water.*
　　　　　　　　　　　　　　{ *Ore of iron from marfhes.*

Phofphate of magnefia.　　　} *Phofphate of magnefia.*
　Phofphas magnefiæ.

Phofphate of manganefe.
　Phofphas magnefii.

Phofphate of mercury.　　　} *Rofe precipitate of lemery.*
　Phofphas hydrargyri.

Phofphate of molybdena.
　Phofphas molybdeni.

Phofphate of nickel.
　Phofphas niccoli.

Phofphate of gold.
　Phofphas auri.

Phofphate of platina.
　Phofphas platini.

Phofphate of lead.
　Phofphas plumbi.

Phofphate of potafh.
　Phofphas potaffæ.

Phofphate of foda.
　Phofphas fodæ.

Phofphate of foda and ammo-
　niac.　　　　　　　　　 | *Native falt of urine.*
　Phofphas fodæ et ammonia- | *Fufible falts of urine.*
　　calis.

Phofphate, fuperfaturated, of
　foda.　　　　　　　　　} *Sal admirabile perlatum.*
　Phofphus fuperfaturatus fodæ.

Phosphate of tungsten.
Phosphas tunsteni.

Phosphate of zinc.
Phosphas zinci.

Phosphite.
Phosphis, itis. s. m.

{ Salt formed by the union of the phosphorous acid with different bases.

Phosphite of alumina.
Phosphis aluminosus.

Phosphite of ammoniac.
Phosphis ammoniacalis.

Phosphite of antimony.
Phosphis stibii.

Phosphite of silver.
Phosphis argenti.

Phosphite of arsenic.
Phosphis arsenicalis.

Phosphite of barytes.
Phosphis baryticus.

Phosphite of bismuth.
Phosphis bismuthi.

Phosphite of lime.
Phosphis calcareus.

Phosphite of cobalt.
Phosphis cobalti.

Phosphite of copper.
Phosphis cupri.

Phosphite of tin.
Phosphis stanni.

Phosphite of iron.
Phosphis ferri.

Phosphite of magnesia.
Phosphis magnesiæ.

Phosphite of manganese.
Phosphis magnesii.

Phosphite of mercury.
Phosphis hydrargyri.

NEW NAMES.	P	OLD NAMES.

Phosphite of molybdena.
Phosphis molybdeni.

Phosphite of nickel.
Phosphis niccoli.

Phosphite of gold.
Phosphis auri.

Phosphite of platina.
Phosphis platini.

Phosphite of ·lead.
Phosphis plumbi.

Phosphite of potash.
Phosphis potassæ.

Phosphite of soda.
Phosphis sodæ.

Phosphite of tungsten.
Phosphis tunsteni.

Phosphite of zinc.
Phosphis zinci.

Phosphorus.   } *Phosphorus of Kunckel.*
Phosphorum.

Phosphure.   { Combination of non-oxigenated
Phosphoretum.   { phosphorus with different bases.

Phosphure of copper.
Phosphoretum cupri.

Phosphure of iron.   { *Syderum of Bergman.*
Phosphoretum ferri.   { *Syderotete of M. de Morveau.*
                        { *Regulus of syderite.*

Pyro-lignite.   { Salt formed by the union of
Pyro-lignis, tis. f. m. the pyro-ligneous acid with dif-
                      { ferent bases.
                      { Thefe falts had no name in
                      { the old Nomenclature.

Pyro-lignite of alumina.
Pyro-lignis aluminosus.

Pyro-lignite of ammoniac.
Pyro-lignis ammoniacalis.

3 E 3

Pyro-lignite of antimony.
Pyro-lignis stibii.

Pyro-lignite of silver.
Pyro-lignis argenti.

Pyro-lignite of arsenic.
Pyro-lignis arsenicalis.

Pyro-lignite of barytes.
Pyro-lignis baryticus.

Pyro-lignite of bismuth.
Pyro-lignis bismuthi.

Pyro-lignite of lime.
Pyro-lignis calcareus.

Pyro-lignite of cobalt.
Pyro-lignis cobalti.

Pyro-lignite of copper.
Pyro-lignis cupri.

Pyro-lignite of tin.
Pyro-lignis stanni

Pyro-lignite of iron.
Pyro-lignis ferri.

Pyro-lignite of magnesia.
Pyro-lignis magnesiæ.

Pyro-lignite of manganese.
Pyro-lignis magnesii.

Pyro-lignite of mercury.
Pyro-lignis hydrargyri.

Pyro-lignite of molybdena.
Pyro-lignis molybdeni.

Pyro-lignite of nickel.
Pyro-lignis niccoli.

Pyro-lignite of gold.
Pyro-lignis auri.

Pyro-lignite of platina.
Pyro-lignis platini.

Pyro-lignite of lead.
Pyro-lignis plumbi.

Pyro-lignite of potash.
Pyro-lignis potassæ.

Pyro-lignite of foda.
   Pyro-lignis fodæ.

Pyro-lignite of tungften.
   Pyro-lignis tunfteni.

Pyro-lignite of zinc.
   Pyro-lignis zinci.

Pyro-mucites.
   Pyro-mucis, tis, f. m.

       Salts formed by the union of the pyro-mucous acid with different bafes.
       This fpecies of falts has not yet obtained a name in the old Nomenclature.

Pyro-mucite of alumina.
   Pyro-mucis aluminofus.

Pyro-mucite of ammoniac.
   Pyro-mucis ammoniacalis.

Pyro-mucite of antimony.
   Pyro-mucis ftibii.

Pyro-mucite of filver.
   Pyro-mucis argenti.

Pyro-mucite of arfenic.
   Pyro-mucis arfenicalis.

Pyro-mucite of barytes.
   Pyro-mucis baryticus.

Pyro-mucite of bifmuth.
   Pyro mucis bifmuthi.

Pyro-mucite of lime.
   Pyro-mucis calcareus.

Pyro-mucite of cobalt.
   Pyro-mucis cobalti.

Pyro-mucite of copper.
   Pyro-mucis cupri.

Pyro-mucite of tin.
   Pyro-mucis ftanni.

Pyro-mucite of iron.
   Pyro-mucis ferri.

Pyro-mucite of magnefia.
  Pyro-mucis magnefiæ.

Pyro-mucite of manganefe.
  Pyro-mucis magnefii.

Pyro-mucite of mercury.
  Pyro-mucis hydrargyri.

Pyro-mucite of molybdena.
  Pyro-mucis molybdeni.

Pyro-mucite of nickel.
  Pyro-mucis niccoli.

Pyro-mucite of gold.
  Pyro-mucis auri.

Pyro-mucite of platina.
  Pyro-mucis platini.

Pyro-mucite of lead.
  Pyro-mucis plumbi.

Pyro-mucite of potafh.
  Pyro-mucis potaffæ.

Pyro-mucite of foda.
  Pyro-mucis fodæ.

Pyro-mucite of tungften.
  Pyro-mucis tunfteni.

Pyro-mucite of zinc.
  Pyro-mucis zinci.

Pyro-tartarites.
  Pyro-trataris, tis. f. m.

{ Salts formed by the union of the pyro-tartareous acid with different bafes.

Pyro-tartarite of alumina.
  Pyro-tartaris aluminofus.

Pyro-tartarite of ammoniac.
  Pyro-tartaris ammoniacalis.

Pyro-tartarite of antimony.
  Pyro-tartaris ftibii.

Pyro-tartarite of filver.
  Pyro-tartaris argenti.

Pyro-tartarite of arfenic.
  Pyro-tartaris arfenicalis.

NEW NAMES.	P	OLD NAMES

Pyro-tartarite of barytes.
  Pyro-tartaris baryticus.
Pyro-tartarite of bifmuth.
  Pyro-tartaris bifmuthi.
Pyro-tartarite of lime.
  Pyro-tartaris calcareus.
Pyro-tartarite of cobalt.
  Pyro-tartaris cobalti.
Pyro-tartarite of copper,
  Pyro-tartaris cupri.
Pyro-tartarite of tin.
  Pyro-tartaris ftanni.
Pyro-tartarite of iron.
  Pyro-tartaris ferri.
Pyro-tartarite of magnefia,
  Pyro-tartaris magnefiæ.
Pyro-tartarite of manganefc.
  Pyro-tartaris magnefii.
Pyro-tartarite of mercury.
  Pyro-tartaris hydrargyri.
Pyro-tartarite of molybdena,
  Pyro-tartaris molybdeni.
Pyro-tartarite of nickel.
  Pyro tartaris niccoli.
Pyro-tartarite of gold.
  Pyro-tartaris auri.
Pyro-tartarite of platina.
  Pyro-tartaris platini.
Pyro-tartarite of lead.
  Pyro-tartaris plumbi.
Pyro-tartarite of potafh.
  Pyro-tartaris potaffæ.
Pyro-tartarite of foda.
  Pyro-tartaris fodæ.
Pyro-tartarite of tungften.
  Pyro-tartaris tunfteni.
Pyro-tartarite of zinc.
  Pyro-tartaris zinci.

Platina.
   Platinum.

{ *Juan blanca.*
  Platina.
  Platina del pinto.

Potash.
   Potassa, æ.

} *Vegetable caustic fixed alkali.*

Potash, melted.
   Potassa fusa.

} *Lapis causticus.*

Potash, siliceous fluid.
   Potassa silicea fluida.

} *Liquor of flints.*

Prussiate.
   Prussias, tis. f. m.

  Salts formed by the union of
the Prussic acid, or colouring
matter of Prussian blue, with
different bases.
  This genus of salts had no
name in the old Nomenclature.

Prussiate of alumina.
   Prussias aluminosus.

Prussiate of ammoniac.
   Prussias ammoniacalis.

Prussiate of antimony.
   Prussias stibii.

Prussiate of silver.
   Prussias argenti.

Prussiate of arsenic.
   Prussias arsenicalis.

Prussiate of barytes.
   Prussias baryticus.

Prussiate of bismuth.
   Prussias bismuthi.

Prussiate of lime.
   Prussias calcareus.

{ *Calcareous prussiate.*
  Prussian lime-water.

Prussiate of cobalt.
   Prussias cobalti.

Prussiate of copper.
   Prussias cupri.

Prussiate of tin.
   Prussias stanni.

NEW NAMES.	P	OLD NAMES.

Prussiate of iron.
 Prussias ferri.
 { Prussian blue.
 { Berlin blue.

Prussiate of magnesia.
 Prussias magnesiæ.

Prussiate of manganese.
 Prussias magnesii.

Prussiate of mercury.
 Prussias hydrargyri.

Prussiate of molybdena,
 Prussias molybdeni.

Prussiate of nickel.
 Prussias niccoli.

Prussiate of gold.
 Prussias auri.

Prussiate of platina.
 Prussias platini.

Prussiate of lead.
 Prussias plumbi.

Prussiate of potash.
 Prussias potassæ.
 } *Liquor saturated with the co-*
 } *louring part of Prussian blue.*

Prussiate, ferruginous saturated,
 of potash.
  Prussias potassæ ferruginosus
  saturatus.
 } *Prussian alkali.*

Prussiate, ferruginous, not sa-
 turated, of potash.
  Prussias potassæ ferruginosus
  non saturatus.
 } *Phlogisticated alkali.*

Prussiate of soda.
 Prussias sodæ.

Pyrophorus of Homberg.
 Pyrophorum Hombergii.
 } *Pyrophorus of Homberg.*

R

Resins.
 Resinæ.
 } *Resins.*

NEW NAMES.	OLD NAMES.

S

Saccho-late. *Saccholas, tis. f. m.*	Salts formed by the union of the faccho-lactic acid with different bafes. This fpecies of falts has no name in the old Nomenclature.

Saccho-late of alumina.
Saccholas aluminofus.

Saccho-late of ammoniac.
Saccholas ammoniacalis.

Saccho-late of antimony.
Saccholas ftibii.

Saccho-late of filver.
Saccholas argenti.

Saccho-late of arfenic.
Saccholas arfenicalis.

Saccho-late of barytes.
Saccholas baryticus.

Saccho-late of bifmuth.
Saccholas bifmuthi.

Saccho-late of lime.
Saccholas calcareus.

Saccho-late of cobalt.
Saccholas cobalti.

Saccho-late of copper.
Saccholas cupri.

Saccho-late of tin.
Saccholas ftanni.

Saccho-late of iron.
Saccholas ferri.

Saccho-late of magnefia.
Saccolas magnefiæ.

Saccho-late of manganefe.
Saccholas magnefii.

Saccho-late of mercury.
Saccholas hydrargyri.

Saccho-late of molybdena.
Saccholas molybdeni.

Saccho-late of nickel.
Saccholas niccoli.

Saccho-late of gold.
Saccholas auri.

Saccho-late of platina.
Saccholas platini.

Saccho-late of lead.
Saccholas plumbi.

Saccho-late of potash.
Saccholas potaffæ.

Saccho-late of foda.
Saccholas fodæ.

Saccho-late of tungften.
Saccholas tunfteni.

Saccho-late of zinc.
Saccholas zinci.

Saponulæ.
Saponuli.
{ Combinations of volatile or ef-
fential oils with different bafes.

Saponulæ, acid.
Saponuli acidi.
{ Combinations of volatile or ef-
fential oils with different acids.

Saponula of alumina.
Saponulus aluminofus.
{ Soap compofed of volatile óil,
combined with the bafe of alum.

Saponula, ammoniacal.
Saponulus ammoniacalis.
{ Soap compofed of volatile oil,
combined with ammoniac.

Saponula of barytes.
Saponulus barytæ.
{ Soap compofed of volatile oil,
combined with barytes.

Saponula of lime.
Saponulus calcareus.
{ Soap compofed of volatile oil,
combined with lime.

Saponula of potash.
Saponulus potaffæ.
{ Soap compofed of volatile oil,
combined with potafh, or *foap*
of Starkey.

Saponulæ of foda.
Saponuli fodæ.
{ Soaps compofed of volatile oils,
combined with fixed mineral al-
kali, or foda.

Saponulæ, metallic.
Saponuli metallici.
{ Soaps compofed of volatile oils,
united to metallic fubftances.

{ Salts formed by the union of
the acid of greafe, or the febacic
acid, with different bafes.
    Thefe falts have no name in
the ancient Nomenclature.

Sebate.
    Sebas, tis. f. m.

Sebate of alumina.
    Sebas aluminofus.

Sebate of ammoniac.
    Sebas ammoniacalis.

Sebate of antimony.
    Sebas ftibii.

Sebate of filver.
    Sebas argenti.

Sebate of arfenic.
    Sebas arfenicalis.

Sebate of barytes.
    Sebas baryticus.

Sebate of bifmuth.
    Sebas bifmuthi.

Sebate of lime.
    Sebas calcareus.

Sebate of cobalt.
    Sebas cobalti.

Sebate of copper.
    Sebas cupri.

Sebate of tin.
    Sebas ftanni.

Sebate of iron.
    Sebas ferri.

Sebate of magnefia.
    Sebas magnefiæ.

Sebate of manganefe.
    Sebas magnefii.

Sebate of mercury.
    Sebas hydrargyri.

Sebate of molybdena.
    Sebas molybdeni.

New Names.	S	Old Names.

Sebate of nickel.
Sebas niccoli.

Sebate of gold.
Sebas auri.

Sebate of platina.
Sebas platini.

Sebate of lead.
Sebas plumbi.

Sebate of potash.
Sebas potaſſæ.

Sebate of ſoda.
Sebas ſodæ.

Sebate of tungſten.
Sebas tunſteni.

Sebate of zinc.
Sebas zinci.

Semi-metals. — *Semi-metals.*

Silices, *or* ſiliceous earth.
Silica, terra ſilicea. — { *Quartzoſe earth.* / *Siliceous earth.* / *Vitrifiable earth.* }

Silver.
Argentum. — { *Diana.* / *Luna.* / *Silver.* }

Soaps.
Sapones. — { Combinations of fat or fixed oils with different baſes. }

Soaps, acid.
Sapones acidi. — { Combinations of fat or fixed oils with different acids. }

Soap of alumina.
Sapo aluminoſus. — { Soap compoſed of fixed oil, combined with alumina. }

Soap, ammoniacal.
Sapo ammoniacalis. — { Soap compoſed of fixed oil, combined with volatile alkali. }

Soap of barytes.
Sapo baryticus. — { Soap compoſed of fixed oil, combined with barytes. }

Soap of lime.
Sapo calcareus. — { Soap compoſed of fixed oil, combined with lime. }

Soap of magneſia.
Sapo magneſiæ. — { Soap compoſed of fixed oil, combined with magneſia. }

NEW NAMES.   S   OLD NAMES.

Soap of potash.
  Sapo potassæ.
{ Soap composed of fixed oil, combined with fixed vegetable alkali.

Soap of soda.
  Sapo sodæ.
{ Soap composed of fixed oil, combined with fixed mineral alkali.

Soaps, metallic.
  Sapones metallici.
{ Combinations of fat or fixed oils with metallic substances.

Soda.
  Soda.
{ *Caustic soda.*
  Marine alkali.
  Mineral alkali.

Starch.
  Amylum.
} *Starch.*

Steel.
  Chalybs.
} *Steel.*

Succinate.
  Succinas, tis. f. m.
{ Salts formed by the combination of the succinic acid with different bases.

Succinate of alumina.
  Succinas aluminosus.

Succinate of ammoniac.
  Succinas ammoniacalis.

Succinate of antimony.
  Succinas stibii.

Succinate of arsenic.
  Succinas arsenicalis.

Succinate of barytes.
  Succinas baryticus.

Succinate of bismuth.
  Succinas bismuthi.

Succinate of lime.
  Succinas calcareus.

Succinate of cobalt.
  Succinas cobalti.

Succinate of copper.
  Succinas cupri.

Succinate of tin.
  Succinas stanni.

Succinate of iron,
  Succinas ferri.

NEW NAMES.	S	OLD NAMES.

Succinate of magnesia.
 Succinas magnesiæ.

Succinate of manganese.
 Succinas magnesii.

Succinate of mercury.
 Succinas hydrargyri.

Succinate of molybdena.
 Succinas molybdeni.

Succinate of nickel.
 Succinas niccoli.

Succinate of gold.
 Succinas auri.

Succinate of platina.
 Succinas platinæ.

Succinate of lead.
 Succinas plumbi.

Succinate of potash.
 Succinas potassæ.

Succinate of soda.
 Succinas sodæ.

Succinate of tungsten.
 Succinas tunsteni.

Succinate of zinc.
 Succinas zinci.

Succinum, or amber.   { *Karabeum.*
 Succinum.   { *Yellow amber.*
                       { *Amber.*

Sugar.   }
 Saccharum.   } *Sugar.*

Sugar, crystallised.   }
 Saccharum crystallisatum. } *Sugar candy.*

Sugar of milk.   { *Sugar of milk.*
 Saccharum lactis.   { *Salt of milk.*

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Sulphates.
   Sulphas, tis. f. m.

{   Salts formed by the combination of the sulphuric acid with different bases.

Sulphate of alumina.
   Sulphas aluminosus.

{ *Alum.*
   Argillaceous vitriol.

Sulphate, ammoniacal.
   Sulphas ammoniacalis.

{ *Ammoniacal vitriolic salt.*
   Ammoniacal salt (a secret of Glauber's).
   Ammoniacal vitriol.

Sulphate of antimony.
   Sulphas stibii.

} *Vitriol of antimony.*

Sulphate of silver.
   Sulphas argenti.

{ *Vitriol of silver.*
   Vitriol of Luna.

Sulphate of arsenic.
   Sulphas arsenicalis.

} *Vitriol of arsenic.*

Sulphate of barytes.
   Sulphas baryticus.

{ *Ponderous spar.*
   Barotic vitriol.

Sulphate of bismuth.
   Sulphas bismuthi.

} *Vitriol of bismuth.*

Sulphate of lime.
   Sulphas calcareus.

{ *Vitriol of lime.*
   Calcareous vitriol.
   Selenite.
   Gypsum.

Sulphate of cobalt.
   Sulphas cobalti.

} *Vitriol of cobalt.*

Sulphate of copper.
   Sulphas cupri.

{ *Vitriol of Cyprus.*
   Blue vitriol.
   Vitriol of copper, or of Venus.
   Blue copperas.

Sulphate of tin.
   Sulphas stanni.

} *Vitriol of tin.*

Sulphate of iron.
   Sulphas ferri.

{ *Martial vitriol.*
   Green vitriol.
   Vitriol of iron.
   Green copperas.

Sulphate of magnefia.
Sulphas magnefiæ.

{ *Magnefian vitriol.*
Bitter cathartic falt.
Epfom falt.
Salt (de canal).
Salt of Seydfchutz.
Salt of Sedlitz.

Sulphate of manganese.
Sulphas magnefii.

} *Vitriol of manganefe.*

Sulphate of mercury.
Sulphas hydrargyri.

} *Vitriol of mercury.*

Sulphate of molybdena.
Sulphas molybdeni.

Sulphate of nickel.
Sulphas niccoli.

Sulphate of gold.
Sulphas auri.

Sulphate of platina.
Sulphas platini.

Sulphate of lead.
Sulphas plumbi.

} *Vitriol of lead.*

Sulphate of potafh.
Sulphas potaffæ.

{ *Vitriol of potafh.*
Sal de duobus.
Vitriolated tartar.
Arcanum duplicatum.
Sal polychrefl of Glafer.

Sulphate of foda.
Sulphas fodæ.

} *Glauber's falt.*
Vitriol of foda.

Sulphate of tungften.
Sulphas tunfteni.

Sulphate of zinc.
Sulphas zinci.

{ *Vitriol of zinc.*
White vitriol.
Goflard's vitriol.
White copperas.

Sulphite.
Sulphis, tis.

{ Salt formed by the com-
bination of the fulphureous
acid with different bafes.

Sulphite of alumina.
Sulphis aluminofus.

Sulphite of ammoniac.
Sulphis ammoniacalis.

Sulphite of antimony.
Sulphis ftibii.

Sulphite of filver.
Sulphis argenti.

Sulphite of arfenic.
Sulphis arfenicalis.

Sulphite of barytes.
Sulphis baryticus.

Sulphite of bifmuth.
Sulphis bifmuthi.

Sulphite of lime.
Sulphis calcareus.

Sulphite of cobalt.
Sulphis cobalti.

Sulphite of copper.
Sulphis cupri.

Sulphite of tin.
Sulphis ftanni.

Sulphite of iron.
Sulphis ferri.

Sulphite of magnefia.
Sulphis magnefiæ.

Sulphite of manganefe.
Sulphis magnefii.

Sulphite of mercury.
Sulphis hydrargyri.

Sulphite of molybdena.
Sulphis molybdeni.

Sulphite of nickel.
Sulphis niccoli.

NEW NAMES.	S	OLD NAMES.

Sulphite of gold.
Sulphis auri.

Sulphite of platina.
Sulphis platini.

Sulphite of lead.
Sulphis plumbi.

Sulphite of potash.
Sulphis potaſſæ. } *Sulphureous ſalt of Stahl.*

Sulphite of ſoda.
Sulphis ſodæ.

Sulphite of tungſten.
Sulphis tunſteni.

Sulphite of zinc.
Sulphis zinci.

Sulphur.
Sulphur. } *Sulphur.*

Sulphur, ſublimated.
Sulphur ſublimatum. } *Flowers of ſulphur.*

Sulphures, alkaline.
Sulphureta alkalina. } *Alkaline liver of ſulphur.* *Alkaline hepars.*

Sulphure of alumina.
Sulphuretum aluminæ.

Sulphure, ammoniacal.
Sulphuretum ammoniacale. { *Fuming liquor of Boyle.* *Volatile alkaline liver of ſulphur.*

Sulphure of antimony.
Sulphuretum ſtibii. } *Antimony.*

Sulphure, native, of antimony.
Sulphuretum ſtibii nativum. } *Ore of antimony.*

Sulphure of ſilver.
Sulphuretum argenti. } *Blanckmal.*

Sulphure of barytes.
Sulphuretum barytæ. } *Barotic liver of ſulphur.*

Sulphure of biſmuth.
Sulphuretum biſmuthi.

3 F 3

Sulphure, calcareous.
Sulphuretum calcareum.
         { *Calcareous liver of sulphur.*

Sulphure of cobalt.
Sulphuretum cobalti.

Sulphure of copper.
Sulphuretum cupri.
         } *Pyrites of copper.*

Sulphure of tin.
Sulphuretum stanni.

Sulphure of iron.
Sulphuretum ferri.
         } *Martial pyrites.*

Sulphure of fixed oil.
Sulphuretum olei fixi.
         } *Balsam of sulphur.*

Sulphure of volatile oil.
Sulphuretum olei volatilis.
         } *Magnesian liver of sulphur.*

Sulphure of magnesia.
Sulphuretum magnesiæ.
         } *Liver of magnesian sulphur.*

Sulphure of manganese.
Sulphuretum magnesii.

Sulphure of mercury.
Sulphuretum hydrargyri.

Sulphures, metallic.
Sulphureta metallica.
         } *Combinations of sulphur with metals.*

Sulphure of molybdena.
Sulphuretum molybdeni.

Sulphure of nickel.
Sulphuretum niccoli.

Sulphure of gold.
Sulphuretum auri.

Sulphure of platina.
Sulphuretum platini.

Sulphure of lead.
Sulphuretum plumbi.

Sulphure of potash.
Sulphuretum potassæ.
         } *Liver of sulphur with a base of vegetable alkali.*

NEW NAMES.	S	OLD NAMES.

Sulphure, antimoniated, of potaſh.
  Sulphuretum potaſſæ ſtibiatum. } *Antimoniated liver of ſulphur.*

Sulphure of ſoda.
  Sulphuretum ſodæ. } *Liver of ſulphur with a baſe of fixed mineral alkali.*

Sulphure, antimoniated, of ſoda.
  Sulphuretum ſodæ ſtibiatum. } *Antimoniated liver of ſulphur.*

Sulphure of tungſten.
  Sulphuretum tunſteni.

Sulphure of zinc.
  Sulphuretum zinci. } *Blende,* or *falſe galena.*

Sulphures, earthy.
  Sulphureta terrea. } *Earthy livers of ſulphur.*
Earthy hepars.

T

Tartar.
  Tartarus. } *Crude tartar.*

Tartarite.
  Tartaris, tis, ſ. m. { Salt formed by the combination of the tartareous acid with different baſes.

Tartarite, acidulous, of potaſh.
  Tartaris acidulus potaſſæ. { *Tartar.*
Cream of tartar.
Cryſtals of tartar.

Tartarite of alumina.
  Tartaris aluminoſus.

Tartarite of ammoniac.
  Tartaris ammoniacalis. } *Ammoniacal tartar.*
Tartareous ammoniacal ſalt.

Tartarite of antimony.
  Tartaris ſtibii.

Tartarite of filver.
    Tartaris argenti.

Tartarite of arfenic.
    Tartaris arfenicalis.

Tartarite of barytes.
    Tartaris baryticus.

Tartarite of bifmuth.
    Tartaris bifmuthi.

Tartarite of lime.   } *Calcareous Tartar.*
    Tartaris calcareus.

Tartarite of cobalt.
    Tartaris cobalti.

Tartarite of copper.
    Tartaris cupri.

Tartarite of tin.
    Tartaris ftanni.

Tartarite of iron.
    Tartaris ferri.

Tartarite of magnefia.
    Tartaris magnefiæ.

Tartarite of manganefe.
    Tartaris magnefii.

Tartarite of mercury.
    Tartaris hydrargyri.

Tartarite of molybdena.
    Tartaris molybdæni.

Tartarite of nickel.
    Tartaris niccoli.

Tartarite of gold.
    Tartaris auri.

Tartarite of platina.
    Tartaris platini.

NEW NAMES.	T	OLD NAMES.

Tartarite of lead.
　Tartaris plumbi. } *Saturnine tartar.*

Tartarite of potash.
　Tartaris potassæ.
{ *Soluble tartar.*
Tartarized tartar.
Tartar of potash.
Vegetable salt.

Tartarite, antimoniated, of potash.
　Tartaris potassæ stibiatus.
{ *Stibiated tartar.*
Tartar emetic.
Antimoniated tartar.
Emetic.

Tartarite, ferruginous, of potash.
　Tartaris potassæ ferrugineus.
{ *Chalybeated tartar.*
Soluble martial tartar.

Tartarite of potash, composed
　of antimony.
　　Tartaris potassæ stibiatus.
} *Tartarized tartar, containing antimony.*

Tartarite of soda.
　Tartaris sodæ.
{ *Tartar of soda.*
Polychrest salt of Rochelle.
Salt of Seignette.

Tartarite of tungsten.
　Tartaris tunsteni.

Tartarite of zinc.
　Tartaris zinci.

Tin.
　Stannum.
{ *Tin.*
Jupiter.

Tunstate.
　Tunsias, tis. s. m.
{ Salt formed by the combination of the tunstic acid with different bases.
　This genus of salt has no name in the old Nomenclature.

Tunstate of alumina.
　Tunstas aluminosus.

Tunstate of ammoniac.
　Tunstas ammoniacalis.

Tunstate of antimony.
　Tunstas stibii.

Tunſtate of ſilver.
  Tunſtas argenti.

Tunſtate of arſenic.
  Tunſtas arſenicalis.

Tunſtate of barytes.
  Tunſtas baryticus.

Tunſtate of biſmuth.
  Tunſtas biſmuthi.

Tunſtate of lime.
  Tunſtas calcareus.

Tunſtate of cobalt.
  Tunſtas cobalti.

Tunſtate of copper.
  Tunſtas cupri.

Tunſtate of tin.
  Tunſtas ſtanni.

Tunſtate of iron.
  Tunſtas ferri.

Tunſtate of magneſia.
  Tunſtas magneſiæ.

Tunſtate of manganeſe.
  Tunſtas magneſii.

Tunſtate of mercury.
  Tunſtas hydrargyri.

Tunſtate of molybdena.
  Tunſtas molybdeni.

Tunſtate of nickel.
  Tunſtas niccoli.

Tunſtate of gold.
  Tuaſtas auri.

Tunſtate of platina.
  Tunſtas platini.

Tunſtate of lead.
  Tanſtas plumbi.

New Names.	T	Old Names.

Tunftate of potafh.
   Tunftas potaffæ.

Tunftate of foda.
   Tunftas fodæ.

Tunftate of tungften.
   Tunftas tunfteni.

Tunftate of zinc.
   Tunftas zinci.

W

New Names	Old Names
Water.	*Water.*
Water, lime.	*Lime-water.*
Water, diftilled.	*Diftilled water.*
Waters impregnated with carbonic acid.	{ *Acidulous waters.* { *Gazeous waters.*
Waters, fulphurated.	*Hepatic waters.*

Z

Zinc.

F I N I S.

I N D E X.

B

D

F

G

T

F I N I S.

A TABLE, EXHIBITING THE CHEMICAL NOMENCLATURE

Proposed by Messieurs De MORVEAU, LAVOISIER, BERTHOLLET, and De FOURCROY, in May 1787.

	I. SUBSTANCES, THAT HAVE NOT BEEN YET DECOMPOSED.		II. THE SAME SUBSTANCES REDUCED INTO THE STATE OF GAS BY THE ADDITION OF CALORIC.		III. THE SAME SUBSTANCES COMBINED WITH OXIGENE.		IV. THE SAME SUBSTANCES IN AN OXIGENATED GAZEOUS STATE.		V. THESE OXIGENATED SUBSTANCES NEUTRALIZED BY THE ADDITION OF BASES.		VI. THE SAME PRIMARY SUBSTANCES COMBINED WITH OTHER SUBSTANCES, BUT NOT ACIDIFIED.		
	NAMES NEWLY INVENTED OR ADOPTED	ANCIENT NAMES	NAMES NEWLY INVENTED OR ADOPTED	ANCIENT NAMES	NAMES NEWLY INVENTED OR ADOPTED	ANCIENT NAMES	NAMES NEWLY INVENTED OR ADOPTED	ANCIENT NAMES	NAMES NEWLY INVENTED OR ADOPTED	ANCIENT NAMES	NAMES NEWLY INVENTED OR ADOPTED	ANCIENT NAMES	
1	Light.	Light, or matter of heat.	—	—	—	—	—	—	—	—	—	—	1
2	Caloric.	The base of vital air.	—	—	—	—	—	—	—	—	—	—	2
3	Oxigene.		Oxigenous gas. N.B. It appears that light contributes to the reduction of oxigene into a gazeous state.	Dephlogisticated or vital air.	—	—	—	—	—	—	—	—	3
4	Hydrogene.	The base of inflammable air.	Hydrogenous gas.	Inflammable gas.	Water.	Water.	—	—	—	—	—	—	4
5	Azote, or the radical principle of the nitric acid.	The base of phlogisticated air, or of atmospheric mephitis.	Azotic gas.	Phlogisticated air, or atmospheric mephitis.	The base of nitrous gas. Nitric acid. With an excess of azote, Nitrous acid.	The base of nitrous gas. White nitrous acid. Fuming nitrous acid.	Nitrous gas. Nitrous acid gas.		Nitrate of potash, of soda, &c. Nitrite of potash.	Common nitre. Cubic nitre.	Carbure of iron.	Plumbago.	5
6	Carbone, or the radical principle of the carbonic acid.	Pure coal.	—	—	Carbonic acid.	Fixed air, or cretaceous acid.	Carbonic acid gas.	Fixed air, mephitic air.	Carbonate { of lime, of potash, &c. of iron, &c. of soda, of lime.	Chalk. Effervescent alkalies. Rust of iron, &c. Vitriolated tartar. Glauber salt. Selenite.	Sulphure { of iron. of antimony. of lead.	Factitious iron pyrites. Antimony. Galena.	6
7	Sulphur, or the radical principle of the sulphuric acid.		—	—	Sulphuric acid. With less oxigene, Sulphureous acid.	Vitriolic acid. Sulphureous acid.	Sulphureous acid gas.	Sulphureous acid gas.	Sulphate { of aluminous earth. of barytes. of iron, &c. Sulphite of potash, &c.	Alum. Ponderous spar. Vitriol of iron, &c. Stahl's sulphureous salt.	Sulph. hydrogenous gas. Sulphure of potash. Sulphure of soda. Alkaline sulphures with metals suspended in them. Alkaline sulphure with carbonaceous matters suspended in it.	Hepatic gas. Alkaline livers of sulphur. Metallic livers of sulphur. Liver of sulphur with carbonaceous matters suspended in it.	7
8	Phosphore, or the radical principle of the phosphoric acid.		—	—	Phosphoric acid. With a smaller proportion of oxigene, Phosphorous acid.	Phosphoric acid. Fuming or volatile phosphoric acid.	—	—	Phosphate of soda. Calcareous phosphite. Super-saturated phosphate of soda. Phosphite of potash, &c.	Phosphoric salt with a base of natron. Earth of bones. Haupt's sal perlatum.	Phosphorised hydrogenous gas. Phosphure of iron.	Phosphoric gas. Sydrite.	8
9	Radical principle of the muriatic acid.		—	—	Muriatic acid. With an excess of oxigene, Oxigenated muriatic acid.	Marine acid. Dephlogisticated marine acid.	Muriatic acid gas. Oxigenated muriatic acid gas.	Marine acid gas. Dephlogisticated marine acid gas.	Muriate of potash. Muriate of soda. Calcareous muriate, &c. Ammoniacal muriate. Oxigenated muriate of soda, &c.	Febrifuge salt of Sylvius. Marine salt. Calcareous marine salt. Sal ammoniac.	—	—	9
10	Radical principle of the boracic acid.		—	—	Boracic acid.	Sedative salt.	—	—	Borate superfaturated with soda, or borax. Borate of soda, &c. soda faturated with the acid.	Common borax.	—	—	10
11	Radical principle of the fluoric acid.		—	—	Fluoric acid.	Acid of spar.	Fluoric acid gas.	Spathose gas.	Fluate of lime, &c.	Fluor spar.	—	—	11
12	Radical principle of the succinic acid.		—	—	Succinic acid.	Volatile salt of amber.	—	—	Succinate of soda, &c.	—	—	—	12
13	Radical principle of the acetic acid.		—	—	Acetous acid.	Distilled vinegar.	—	—	Acetite { of potash. of soda. of lime. of ammoniac. of lead. of copper.	Terra foliata tartari. Mineral terra foliata. Calcareous acetous salt. Spirit of Mendererus. Saccharum saturni. Verdigris.	—	—	13
14	Radical principle of the tartareous acid.		—	—	With more oxigene, Acetic acid. Tartareous acid.	Radical vinegar.	—	—	Acetate of soda, &c. Acidulous tartarite of potash. Tartarite of potash. Tartarite of soda, &c.	Cream of tartar. Vegetable salt. Salt of Seignette.	—	—	14
15	Radical principle of the pyro-tartareous acid.		—	—	Pyro-tartareous acid.	Empyreumatic tartareous acid, or spirit of tartar.	—	—	Pyro-tartarite of lime. Pyro-tartarite of iron, &c.	—	—	—	15
16	Radical principle of the oxalic acid.		—	—	Oxalic acid.	Saccharine acid.	—	—	Acidulous oxalate of potash. Oxalate of lime, of soda, &c.	Salt of Sorrel.	—	—	16
17	Radical principle of the gallic acid.		—	—	Gallic acid.	Astringent principle.	—	—	Gallate of soda. of magnesia. of iron, &c.	—	—	—	17
18	Radical principle of the citric acid.		—	—	Citric acid.	Lemon juice.	—	—	Citrate of potash. of lead, &c.	Terra foliata with lemon juice.	—	—	18
19	Radical principle of the malic acid.		—	—	Malic acid.	Acid of apples.	—	—	Malate of lime, &c.	—	—	—	19
20	Radical principle of the benzoic acid.		—	—	Benzoic acid.	Flowers of benzoin.	—	—	Aluminous benzoate. Benzoate of iron, &c.	—	—	—	20
21	Radical principle of the pyro-ligneous acid.		—	—	Pyro-ligneous acid.	Spirit of wood.	—	—	Pyro-lignite of lime. Pyro-lignite of zinc, &c.	—	—	—	21
22	Radical principle of the pyro-mucous acid.		—	—	Pyro-mucous acid.	Spirit of honey, sugar, &c.	—	—	Pyro mucite of magnesia. Ammoniacal, &c. pyro-mucite.	—	—	—	22
23	Radical principle of the camphoric acid.		—	—	Camphoric acid.		—	—	Camphorate of soda, &c.	—	—	—	23
24	Radical principle of the lactic acid.		—	—	Lactic acid.	Acid of milk.	—	—	Lactate of lime, &c.	—	—	—	24
25	Radical principle of the saccho-lactic acid.		—	—	Saccho-lactic acid.	Acid of sugar of milk.	—	—	Saccho-lactate of iron, &c.	—	—	—	25
26	Radical principle of the formic acid.		—	—	Formic acid.	Acid of ants.	—	—	Ammoniacal, &c. formiate.	Spirit of ingaduinity.	—	—	26
27	Radical principle of the Prussic acid.		—	—	Prussic acid.	Colouring matter of Prussian blue.	—	—	Prussiate of potash, &c. Prussiate of iron, &c.	Phlogisticated alkali, or Prussian alkali. Prussian blue.	—	—	27
28	Radical principle of the sebacic acid.		—	—	Sebacic acid.	Acid of grease.	—	—	Sebate of lime, &c.	—	—	—	28
29	Radical principle of the lithic acid.		—	—	Lithic acid.	Stone in the bladder.	—	—	Lithiate of soda, &c.	—	—	—	29
30	Radical principle of the bombic acid.		—	—	Bombic acid.	Acid of the silk-worm.	—	—	Bombiate of iron, &c.	—	—	—	30

OXIDES WITH VARIOUS BASES.

	I.		II.		III.		IV.		V.		VI.		
31	Arsenic.	Regulus of arsenic.	—	—	Oxide of arsenic.	White arsenic, or calx of arsenic.	Yellow { sulphurated Red { oxide of arsenic. Arsenical oxide of potash. Sulphure of molybdena.	Orpiment. Realgar. Liver of arsenic. Molybdena.	Arseniate of potash, &c. Arseniate of copper.	Macquer's arsenial neutral salt.	Alloy of arsenic and tin.	Arsenicated tin.	31
32	Molybdena.	—	—	—	Oxide of molybdena. Molybdic acid.	Calx of molybdena.	—	—	Molybdate.	—	Alloy, &c.	—	32
33	Tungsten.	—	—	—	Oxide of tungsten. Tungstic acid.	Yellow calx of tungsten.	—	—	Calcareous tungstate.	Scendish tungsten.	Alloy, &c.	—	33
34	Manganese.	Regulus of manganese.	—	—	White { oxide of Black { manganese. Vitreous	Manganese.	—	—	—	—	Alloy of manganese and iron.	—	34
35	Nickel.	—	—	—	Oxide of nickel.	Calx of nickel.	—	—	—	—	Alloy of nickle, &c.	—	35
36	Cobalt.	Regulus of cobalt.	—	—	Grey { oxide of Vitreous { cobalt.	Calx of cobalt.	Alkaline cobaltic oxides.	Precipitate of cobalt again dissolved by alkalies.	—	—	Alloy, &c.	—	36
37	Bismuth.	—	—	—	White { Yellow { oxide of Vitreous { bismuth.	Magistery of bismuth, or white paint. Yellow calx of bismuth. Glass of bismuth.	Sulphurated oxide of bismuth.	Bismuth precipitated by liver of sulphur.	—	—	Alloy, &c.	—	37
38	Antimony.	Regulus of antimony.	—	—	Oxide of antimony { by the nitrous acid, by the muriatic acid, sublimated, vitreous.	Diaphoretic antimony. Powder of Algaroth. Flowers or argent of antimony. Glass of regulus of antimony. Glass of antimony.	Grey { sulphurated Red { oxide of Orange { antimony. Vitreous Alkaline oxide of antimony.	Grey calx of antimony. Kermes mineral. Golden sulphur. Glass and liver of antimony. Retrou's solvent.	—	—	Alloy, &c.	—	38
39	Zinc.	—	—	—	Oxide of zinc. Sublimated oxide of zinc.	Calx of zinc. Flowers of zinc, pompholix, &c.	Sulphurated oxide of zinc.	Precipitate of zinc by liver of sulphur or faltitious blende.	—	—	Alloy, &c.	—	39
40	Iron.	—	—	—	Black { oxide of Red { iron.	Martial æthiops. Astringent, Iron of Mars.	Sulphurated oxide of iron.		—	—	Alloy, &c.	—	40
41	Tin.	—	—	—	White oxide of tin.	Calx or putty of tin.	Yellow sulphurated oxide of tin.	Aurum musivum.	—	—	Alloy, &c.	—	41
42	Lead.	—	—	—	White { Yellow { oxide of Red { lead. Vitreous	Cerusse, or white lead. Massicot. Minium. Litharge.	Sulphurated oxide of lead.	—	—	—	Alloy, &c.	—	42
43	Copper.	—	—	—	Red { Green { oxide of copper. Blue	Brown calx of copper. Green calx of copper, or verdigris. Mountain blue.	Ammoniacal oxide of copper.		—	—	Alloy, &c.	—	43
44	Mercury.	—	—	—	Blackish { mercurial Yellow { oxide. Red	Æthiops per se. Turbith mineral. Precipitate per se.	Black { sulphurated Red { oxide of mercury.	Æthiops mineral. Cinnabar.	—	—	Alloy or amalgam of, &c.	—	44
45	Silver.	—	—	—	Oxide of silver.	Calx of silver.	Sulphurated oxide of silver.		—	—	Alloy, &c.	—	45
46	Platina.	—	—	—	Oxide of platina.	Calx of platina.	—	—	—	—	Alloy, &c.	—	46
47	Gold.	—	—	—	Oxide of gold.	Calx of gold.	—	—	—	—	Alloy of platina & gold.	—	47
48	Siliceous earth.	Vitrifiable earth, quartz, &c.	—	—	—	—	—	—	—	—	—	—	48
49	Aluminous earth.	Clay, or earth of alum, &c.	—	—	—	—	—	—	—	—	—	—	49
50	Barytes.	Terra ponderosa.	—	—	—	—	—	—	—	—	—	—	50
51	Lime.	Calcareous earth.	—	—	—	—	—	—	—	—	—	—	51
52	Magnesia.	—	—	—	—	—	—	—	—	—	—	—	52
53	Potash.	Fixed alkali of tartar, &c.	—	—	—	—	—	—	—	—	—	—	53
54	Soda.	Mineral alkali, marine alkali, natron.	—	—	—	—	—	—	—	—	—	—	54
55	Ammoniac.	Flour, or caustic volatile alkali.	Ammoniacal gas.	Alkaline gas.	—	—	—	—	—	—	—	—	55

DENOMINATIONS newly appropriated to several Substances, which are more compound in their Nature, yet enter into new Combinations without being decomposed.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
New Names.	Mucous matter.	Glutinous matter, or gluten.	Sugar.	Starch.	Fixed oil.	Volatile oil.	The aroma, or aromatous principle.	Resin.	Extractive matter.	Extracto-resinous matter { in which the extractive matter dominates.	Refino-extractive matter { in which the resin predominates.	Feculum.	Alcohol or spirit of wine.	Alcohol { of potash, of gum, &c. of scammoneum, of myrrh, &c.	Nitrous Gallic Muriatic &c. } alcohol.	Sulphuric Muriatic Acetic &c. } ether.	Alkaline Earthy Metallic Sb, souls of turpentine, &c. } of sap.
Ancient Names.	Mucilage.	Gluten matter.	Saccharine matter.	Amylaceous matter.	Fat oil.	Essential oil.	Spiritus rector.	Resin.	Extractive matter.			Feculum.	Spirit of wine.	Tinctures and extracts by alcohol of scammoneum of myrrh, &c.	Dulcified spirit of nitre. Tincture of muriate. Dulcified marine acid.	Ester of Frobenius. Vitriolic ether. Acetous ether, &c.	Alkaline, earthy, metallic soaps. Combinations of soda with oils of turpentine, &c.

TABLE II. *Quadrupeds, divided according to the System of* BRISSON.

	ORDERS.	SECTIONS.	GENERA.	
QUADRUPEDS, Without teeth	I.	Hairy skin	Ant-eater	*Myrmecophaga.*
		Scaly	Manis	*Pholidotus.*
With teeth — With grinders only	II.	Hairy skin	Sloth	*Tardigradus.*
		Bony covering or shell	Armadillo	*Cataphractus.*
Grinders and canine teeth only	III.	Two long tusks and a trunk	Elephant	*Elephas.*
		Two long tusks, no trunk	Sea Cow	*Odobenus.*
Incisive teeth in the lower jaw only	IV.	Ruminant, ungulated; six incisive teeth	Camel	*Camelus.*
	V.	Ruminant, with cloven feet; eight incisive teeth. — Simple horns. Turned upwards. Fore legs longer than hinder legs	Cameleopardalis	*Giraffa.*
		The legs of equal lengths	Goat	*Hircus.*
		Turned back	Sheep	*Aries.*
		Turned sideways	Ox	*Bos.*
		Branched horns	Stag	*Cervus.*
		No horns	Musk	*Tragulus.*
Ungulated feet	VI.	The hoof entire	Horse	*Equus.*
	VII.	The hoof cloven	Hog	*Sus.*
	VIII.	Three ungulated toes on each foot	Rhinoceros	*Rhinoceros.*
	IX. X.	Four ungulated toes before, three behind, Two incisive teeth in each jaw	River Hog	*Hydrochærus.*
		Ten incisive teeth in each jaw	Tapir	*Tapirus.*
	XI.	Four ungulated toes on each foot	River Horse	*Hippopotamus.*
Ungulated feet, and two incisive teeth in each jaw.	XII.	Without canine teeth — Spines on the body	Porcupine	*Hystrix.*
		Without spines. Tail flat and scaly	Beaver	*Castor.*
		Short tail — Long ears	Hare	*Lepus.*
		Short ears	Coney	*Cuniculus.*
		Long tail — Flat	Squirrel	*Sciurus.*
		Round	Dormouse	*Glis.*
		Naked tail	Rat	*Mus.*
		With canine teeth — Without spines on the body	Shrew Mouse	*Musaraneus.*
		With spines	Hedge Hog	*Erinaceus.*
Incisive teeth in both jaws. — Four incisive teeth in each jaw.	XIII.	Separate toes	Monkey	*Simia.*
		Toes joined by a membrane so as to form wings		*Pteropus.*
Four incisive teeth in the upper, and six in the lower jaw.	XIV.	Separate toes	Maucauco	*Prosimia.*
		The fore toe joined so as to form wings	Bat	*Vespertilio.*
Six incisive teeth in the upper, and four in the lower jaw.	XV.		Seal	*Phoca.*
Six incisive teeth in each jaw.	XVI.	The toes separate from each other. Four toes on the fore, and five on the hinder feet	Hyæna	*Hyæna.*
		Five toes on the fore, and four on the hinder feet	Dog	*Canis.*
		Five toes on each foot, First toe remote from the other	Weezel	*Mustela.*
		First toe near the other	Badger	*Meles.*
		Feet which rest on the heel in walking	Bear	*Ursus.*
		Hooked claws which may be drawn back and concealed	Cat	*Felis.*
		The toes joined together by a membrane	Otter	*Lutra.*
Six incisive teeth in the upper, and eight in the lower jaw.	XVII.		Mole	*Talpa.*
Ten incisive teeth in the upper, and eight in the lower jaw.	XVIII.		Opossum	*Philander.*

TABLE III.   *The Ornithologic System of* BRISSON.

ORDERS.   SECTIONS.   GENERA.

BIRDS ARE

Either CLOVEN-FOOTED; that is, they have the toes naked, and apart from each other:

— The legs feathered as low as the calcaneum, or bone which sustains the toes.

  — Four toes all separate from each other, quite to their base.

    — Three toes before, and one behind.

Order	Sections	Genera
I. The beak strait; the upper mandible thickened, and somewhat curved at the point; the nostrils half-covered with a thick soft membrane. It consists of one genus only.	—	Pigeon – *Columba.*
II. The beak conical and curved. It consists of six genera.	1. The head ornamented with appendices. 2. No appendices on the head.	Turkey – *Gallo Pavo.* Cock and Hen – *Gallus.* Guinea Hen – *Meleagris.* Grous – *Lagopus.* Partridge – *Perdix.* Pheasant – *Phasianus.*
III. The beak short and crooked. It consists of five genera.	1. The base of the beak covered with a naked skin. 2. The base of the beak covered with feathers turned forwards.	Hawk – *Accipiter.* Eagle – *Aquila.* Vulture – *Vultur.* Owl – *Asio / Strix.*
IV. The beak long and conical. It consists of six genera.	1. The feathers on the base of the beak turned forward, and covering the nostrils. 2. The feathers at the base of the beak turned backward; the nostrils uncovered.	Chough – *Coracia.* Crow – *Corvus.* Magpie – *Pica.* Roller – *Galgulus.* Oriole – *Icterus.* Bird of Paradise – *Manucodiata.*
V. The beak strait; the upper mandible grooved on each side towards the point. It consists of four genera.	1. The beak convex above. 2. The beak flattened horizontally towards the base, and nearly triangular.	Butcher Bird – *Lanius.* Thrush – *Turdus.* Chatterer – *Cotinga.* Fly-catcher – *Muscicapa.*
VI. The beak strait, and the mandibles not grooved. It consists of two genera.	—	Beef eater – *Buphagus.* Starling – *Sturnus.*
VII. The beak slender, and rather bent. It consists of two genera.	—	Hoopoe – *Upupa.* Promerops – *Promerops.*
VIII. The beak very small, flattened horizontally at its base, and bent at the point; the opening of the mouth appears larger than the head. It consists of two genera.	—	Goat-sucker – *Caprimulgus.* Swallow – *Hirundo.*
IX. The beak conical, and gradually diminishing to the point. It consists of eight genera.	1. The two mandibles strait. 2. The two mandibles crossing each other.	Tanager – *Tangara.* Goldfinch – *Carduelis.* Sparrow – *Passer.* Grosbeak – *Coccothraustes.* Bunting – *Emberiza.* Culy – *Colius.* Bullfinch – *Pyrrhula.* Crossbill – *Loxia.*
X. The beak awl-shaped. It consists of three genera.	1. The nostrils uncovered. 2. The nostrils covered by the feathers at the base of the beak.	Lark – *Alauda.* Beccafico – *Ficedula.* Tit-mouse – *Parus.*
XI. The beak wedge-shaped. It consists of one genus only.	—	Nuthatch – *Sitta.*
XII. The beak filiform. It consists of three genera.	1. The beak curved. 2. The beak flattened horizontally, and a little enlarged at the point: the feet very short.	Creeper – *Certhia.* Humming Bird – *Polytmus / Mellisuga.*

  — Two toes before, and two behind.

Order	Sections	Genera
XIII. Consisting of nine genera.	1. The tongue very long and vermiform, but not longer than the beak. 2. The beak very long, quadrangular, and pointed. 3. The beak somewhat curved, convex at its upper part, and flattened laterally. 4. The beak short and crooked. 5. The beak long, and as thick as the head, indented like a saw; the point of each mandible turned downwards.	Wryneck – *Torquilla.* Wood-pecker – *Picus.* Jacamar – *Galbula.* Barbet – *Bucco.* Cuckow – *Cuculus.* Curucui – *Trogon.* Ani – *Crotophagus.* Parrot – *Psittacus.* Toucan – *Tucana.*

  — The middle toe united with the exterior for the space of three phalanges, and with the interior for the space of one phalanx; four toes; three before, one behind.

Order	Sections	Genera
XIV. — seven genera.	1. The beak short, and flattened laterally near the point. 2. The beak conical, and indented like a saw; the end of each mandible bent downwards. 3. The beak strait, and of a moderate length. 4. The beak curved and sharp. 5. The beak thick, and formed like a scyth.	Rupicola. Manakin – *Manacus.* Motmot – *Momotus.* King's-fisher – *Ispida.* Tody – *Todus.* Bee-eater – *Apiaster.* Hornbill – *Hydrocorax.*

— The lower part of the legs without feathers.

  — Wings too small for flight.

Order	Sections	Genera
XV. — four genera.	1. Two toes before, none behind; the beak strait, somewhat flattened horizontally, and curved at the point; the upper part of the head bald & scaly. 2. Three toes before, none behind. 3. Three toes before, one behind; the beak long and strong; both mandibles hooked at the point.	Ostrich – *Struthio.* Rhea. Casuary – *Casuarius.* Dodo – *Raphus.*

  — Wings large enough for flight.

    — Three toes only, all before.

Order	Sections	Genera
XVI. — four genera.	1. The beak conical and curved. 2. The beak strait, and thickest at the point.	Bustard – *Otis.* Long-Legs – *Himantopus.* Oyster-catcher – *Ostralega.* Plover – *Pluvialis.*

    — Three toes before, and one behind.

Order	Sections	Genera
XVII. — eighteen genera.	1. The beak strait, and thickest near the point. 2. The beak a little turned up, and somewhat flattened horizontally. 3. The beak convex above, and flattened laterally. 4. The beak strait, and flattened laterally. 5. The beak strait and slender. 6. The beak curved in an arc downwards. 7. The beak strait, flattened horizontally, and dilated at its extremity like a spatula. 8. The beak long and thick. 9. The beak short and thick, the upper mandible in the form of a spoon. 10. The beak short and strait, conical at the point; the head adorned with a crown of feathers. 11. The beak conical and curved. 12. The beak conical, flattened at the sides, and the fore part of the head without feathers.	Lapwing – *Vanellus.* Jacana – *Jacana.* Turnstone – *Arenaria.* Pratincole – *Glareola.* Rail – *Rallus.* Sandpiper – *Tringa.* Godwit – *Limosa.* Woodcock – *Scolopax.* Curlew – *Numenius.* Spoonbill – *Platea.* Stork – *Ciconia.* Heron – *Ardea.* Umbre – *Scopus.* Boat-bill – *Cochlearius.* Crown Bird – *Balearica.* Cariama – *Cariama.* Screamer – *Anhima.* Gallinule – *Porphyrio.*

or WEB-FOOTED; that is, they have the toes furnished with membranes.

— The membranes of the feet divided. Four toes; three before and one behind, which are divided, and have membranous edges.

Order	Sections	Genera
XVIII. — three genera.	1. The membranes of the toes simple, the beak strait and acute. 2. The membranes of the toes jagged.	Water Hen – *Gallinula.* Phalarope – *Phalaropus.* Coot – *Fulica.*

— The membranes partly divided; the toes joined together near their base; the legs placed behind near the anus.

Order	Sections	Genera
XIX. — one genus.	—	Grebe – *Colymbus.*

— The membranes entire.

  — The legs placed behind near the anus.

    — Three toes before, connected by a membrane; no toe behind.

Order	Sections	Genera
XX. — three genera.	1. The beak strait and acute. 2. The beak flattened at the sides, with transverse striæ.	Guillemot – *Uria.* Puffin – *Fratercula.* Auk – *Alca.*

    — Three toes before, connected by a membrane; one separate toe behind.

Order	Sections	Genera
XXI. — three genera.	1. The beak strait, the extremity of the upper mandible bent. 2. The beak strait and acute.	Pinguin – *Spheniscus.* Catarractes. Diver – *Mergus.*

  — The legs placed in the middle of the body, and shorter than it.

    — The three anterior toes connected by a membrane. — Without a posterior toe.

Order	Sections	Genera
XXII. — one genus.	—	Albatross – *Albatrus.*

    — A fourth toe behind, separate from the others. — Indented beak.

Order	Sections	Genera
XXIII. — six genera.	1. The beak bent near its point. 2. The beak flattened at the sides.	Shearwater – *Puffinus.* Petrel – *Procellaria.* Arctic Bird – *Stercorarius.* Gull – *Larus.* Tern – *Sterna.* Razorbill – *Rynchopsalia.*

    — Beak not indented.

Order	Sections	Genera
XXIV. — three genera.	1. The beak rather cylindrical; the extremity of the upper mandible bent. 2. The beak convex on its upper part, and flat beneath.	Merganser – *Merganser.* Goose – *Anser.* Duck – *Anas.*

  — The four toes connected by a membrane.

Order	Sections	Genera
XXV. — five genera.	1. The beak acute. 2. The beak hooked at the point.	Darter – *Anhinga.* Tropic Bird – *Lepturus.* Booby – *Sula.* Cormorant – *Phalacrocorax.* Pelican – *Onocrotalus.*

  — The legs longer than the body.

Order	Sections	Genera
XXVI. — three genera.	1. The beak indented, curved in the middle, and the inferior mandible largest. 2. The beak not indented.	Flamingo – *Phœnicopterus.* Avoset – *Avocetta.* Courier – *Corrira.*

TABLE IV.   *The Division of Oviparous Quadrupeds, by* DAUBENTON.

OVIPAROUS QUADRUPEDS.	CLASS I. The body covered with a shell. TORTOISES.	Consisting of 15 species.
	CLASS II. The body naked, with a tail. LIZARDS.	Genus I. Lizards which have the body somewhat tuberculated, and the tail flat. — Consisting of 8 species.
		Genus II. Lizards which have the tail verticillated. — Consisting of 12 species.
		Genus III. Lizards which have the tail round, scaly, and shorter than the body. — Consisting of 5 species.
		Genus IV. Lizards which have the tail round, scaly, and longer than the body. — Consisting of 17 species.
		Genus V. Lizards which have four toes on the fore-feet, and the body smooth. — Consisting of 5 species.
		Genus VI. Winged Lizards. — The Dragon.
	CLASS III. The body naked, without a tail.	Genus I. Toads; the body round, and tuberculated, the legs short. — Consisting of 14 species.
		Genus II. Frogs which have the body long. — Consisting of 11 species.
		Genus III. Frogs which have the toes terminating in a broad flat surface. — Consisting of 9 species.

TABLE V. *A Systematic Table of Oviparous Quadrupeds, by* M. DE LA CEPEDE.

		DIVISIONS.	
CLASS I. OVIPAROUS QUADRUPEDS, having a tail.	**Genus I. TORTOISES.** The body covered with a shell.	I. The toes are very unequal, and assume, towards the extremities, the form of fins.	It consists of 6 species.
		II. The toes very short, and nearly equal.	It consists of 18 species.
	Genus II. LIZARDS. The body not covered with a shell.	I. The tail flat, and five toes on the fore-feet.	It consists of 11 species.
		II. The tail round, five toes on each foot, and scales rising on the back in the form of a crest.	It consists of 5 species.
		III. The tail round, five toes on the fore-feet, and scaly stripes running across the belly.	It consists of 7 species.
		IV. The tail round, and five toes on the fore-feet, but no scaly stripes under the belly.	It consists of 21 species.
		V. The under part of the toes covered with scales, rising one over another, like slates on the roof of a house.	It consists of 3 species.
		VI. Three toes on both the fore and the hinder feet.	It consists of 2 species.
		VII. Membranes, of the form of wings.	It consists of 1 species.
		VIII. Three or four toes on the fore-feet, and four or five toes on the hinder-feet.	It consists of 6 species.
CLASS II. OVIPAROUS QUADRUPEDS, without a tail.	**Genus I. FROGS.** The head and body oblong, and either the one or the other angular.	— — — — — — —	It consists of 12 species.
	Genus II. The body oblong, and balls of viscid matter under the toes.	— — — — — — —	It consists of 7 species.
	Genus III. The body bloated and round.	— — — — — — —	It consists of 14 species.
TWO-FOOTED REPTILES. — — —		I. Two fore-feet.	It consists of 1 species.
		II. Two hinder-feet.	It consists of 1 species.

TABLE VI.   *The Division of Serpents, by* DAUBENTON.

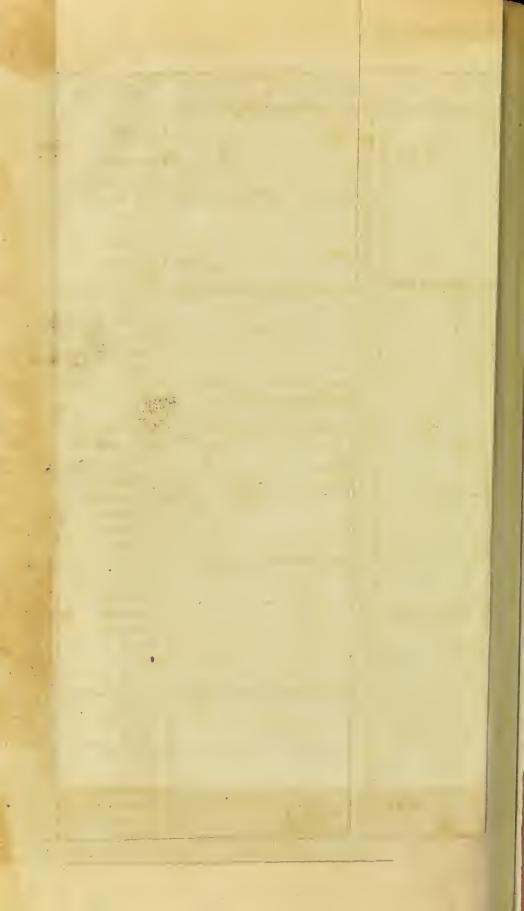| SERPENTS.		
	Genus I. Rattle-snakes; or such as have a Rattle at the extremity of the tail. Crotalus, Linnæi.	It consists of four species.
	Genus II. Serpents which have large scales (Scuta) beneath the body and tail; without a Rattle. Boa, Linn.	It consists of ten species.
	Genus III. Serpents which have large scales (Scuta) beneath the body, and small scales (Squamæ) beneath the tail. Coluber, Linn.	It consists of ninety-six species.
	Genus IV. Serpents which have small scales beneath the body and tail. Anguis, Linn.	It consists of thirteen species.
	Genus V. Serpents which have the body divided into annuli or rings. Amphisbæna, Linn.	It consists of two species.
	Genus VI. Serpents which have the skin naked smooth. Cæcilia, Linn.	It consists of two species.

TABLE VII. *The Ichthyologic System of* GOUAN.

FISHES HAVE	EITHER The gills perfect,	Clafs I. ACANTHOPTERYGII. The fins fupported by fmall bones.	Order I. Apodes. The ventral fins wanting.	1. ———— - Trichiurus. 2. Sword-fifh - Xiphias. 3. ———— - Ophidium.
			Order II. Jugulares. The belly-fins placed beneath the neck.	1. Weveer - Trachinus. 2. ———— - Uranofcopus. 3. Dragonet - Callyonymus. 4. Blenny - Blennius.
			Order III. Thoracici. The ventral fins placed beneath the breaft.	1. Goby - Gobius. 2. ———— - Cepola. 3. Dolphin - Coryphæna. 4. Mackrel - Scomber. 5. Wraffe - Labrus. 6. Gilthead - Sparus. 7. ———— - Chætodon. 8. ———— - Sciæna. 9. Perch - Perca. 10. Father Lafher - Scorpæna. 11. Surmullet - Mullus. 12. Gurnard - Trigla. 13. Bull-head - Cottus. 14. Doree - Zeus. 15. ———— - Trachipterus. 16. Stickle-back - Gafterofteus.
			Order IV. Abdominales. The ventral fins placed beneath the abdomen.	1. Catfifh - Silurus. 2. Mullet - Mugil. 3. ———— - Polynemus. 4. ———— - Theutus. 5. ———— - Elops.
		Clafs II. MALACOPTERYGII. The fins foft, and without bones.	Order I. Apodes.	1. Eel - Muræna. 2. Gymnotus - Gymnotus. 3. Wolf-fifh - Anarhichas. 4. ———— - Stromateus. 5. Launce - Ammodytes.
			Order II. Jugulares.	1. ———— - Lepadegafter. 2. Cod - Gadus.
			Order III. Thoracici.	1. Flounder - Pleuronectes. 2. Sucking-fifh - Echeneis. 3. ———— - Lepidopus.
			Order IV. Abdominales.	1. ———— - Loricaria. 2. Atherine - Atherina. 3. Salmon - Salmo. 4. ———— - Fiftularia. 5. Pike - Efox. 6. Argentine - Argentina. 7. Herring - Clupea. 8. Flying-fifh - Exocætus. 9. Carp - Cyprinus. 10. Loche - Cobitis. 11. ———— - Amia. 12. ———— - Mormyrus.
	OR The gills imperfect.	Clafs III. BRONCHIOSTEGI.	Order I. Apodes.	1. Pipe-fifh - Syngnathus. 2. Baliftes - Baliftes. 3. ———— - Oftracion. 4. ———— - Tetraodon. 5. Sun-fifh - Diodon.
			Order II. Jugulares.	1. Angler - Lophius.
			Order III. Thoracici.	1. Lump-fifh - Cyclopterus.
			Order IV. Abdominales.	1. ———— - Centrifcus. 2. ———— - Pegafus.

TABLE VIII.   *The Entomologic Method of* GEOFFROY.

SECTIONS.	ARTICLES.	ORDERS.	GENERA.
SECT. I. Coleoptera, or Insects with crustaceous shells over their wings..	I. .... Either the shell is hard, and covers the whole abdomen; and their feet have	I. .... Either five articulations to all the feet, such as the	Platycerus. Ptilinus. Scarabæus. Copris. Attelabus. Dermestes. Byrrhus. Anthrenus. Cistela. Peltis. Cucujus. Elater. Buprestis. Bruchus. Lampyris. Cicindela. Omalysus. Hydrophylus. Dyticus. Gyrinus.
		II. .... Or, four articulations to all the feet, such as the	Melolontha. Prionus. Cerambix. Leptura. Stenocorus. Luperus. Cryptocephalus. Crioceris. Altica. Galeruca. Chrysomela. Milabris. Rhinomacer. Curculio. Bostrichus. Clerus. Anthribus. Scolytus. Cassida. Anaspis.
		III. .... Or, three articulations to all the feet, such as	Coccinella. Tritoma. Diaperis.
		IV. .... Or, five articulations in the two first pair of feet, and four only in the hinder pair, such as	Pyrochroa. Cantharis. Tenebrio. Mordella. Notoxus. Cerocoma.
	II. .... Or the shell is hard, and covers only part of the abdomen; and their feet have	I. .... Either five articulations to all the feet, ...	Staphylinus.
		II. .... Or four articulations to all the feet, ...	Necydalis.
		III. .... Or three articulations to all the feet, ...	Forficula.
		IV. .... Or five articulations to the two first pair of feet, and four to the latter, ... - - -	Meloe.
	III. .... The shell is soft, and their feet have	I. .... Either five articulations to the two first pair of feet, and four only to the latter, ...	Blatta.
		II. .... Or two articulations to all the feet, ...	Trips.
		III. .... Or three articulations to all the feet, ...	Gryllus. Acrydium.
		IV. .... Or four articulations to all the feet, ...	Locusta.
		V. .... Or five articulations to all the feet, ...	Mantes.

SECTIONS.	ARTICLES.	GENERA.
II. .... Hemyptera, or insects whose upper wings are half crustaceous, half membranaceous, ...		Cicada. Cimex. Naucoris. Notonecta. Corixa. Hepa. Psylla. Aphis. Chermes. Coccus.
III. .... Insects with four farinaceous wings, ...		Papilio. Sphinx. Pterophorus. Phalæna. Tinea.
IV. .... Insects with four naked membranaceous wings.	I. ... Three articulations to the feet ..	Libellula. Perla.
	II. ... Four articulations to the feet	Raphidia.
	III. ... Five articulations to the feet	Ephemera. Phryganea. Hemerobius. Formicaleo. Panorpa. Crabro. Urocerus. Tenthredo. Cynips. Diplolepis. Euloplus. Ichneumon. Vespa. Apis. Formica.
V. .... Insects with two wings, ...		Oestrus. Tabanus. Asilus. Stratiomys. Musca. Stomoxys. Volucella. Nemotelus. Scatopse. Hyppobosca. Tipula. Bibio. Culex.
VI. .... Insects without wings, ...		Pediculus. Podura. Forbicina. Pulex. Chelifer. Acarus. Phalangium. Aranea. Monoculus. Binoculus. Cancer. Oniscus. Asellus. Scolopendra. Iulus.

TABLE IX.   *A methodical Division of Worms.*

			GENUS.
Section I. Naked Worms.			1. Gordius. 2. Lumbricus. 3. Afcarides. 4. Sanguifuga. 5. Limax. 6. Tænia.
Section II. Covered Worms.	Order I. With univalve fhells.		1. Patella. 2. Haliotis. 3. Tubulus. 4. Nautilus. 5. Cochlea. 6. Nerites. 7. Trochus. 8. Cilindrus. 9. Voluta. 10. Strombis. 11. Buccinum. 12. Murex. 13. Purpura. 14. Porcellana. 15. Globus.
	Order II. With bivalve fhells.		1. Oftrea. 2. Chama. 3. Concha cordis. 4. Pecten. 5. Mytulus. 6. Solen.
	Order III. With polyvalve fhells.		1. Pholas. 2. Balanus. 3. Concha Anatifera. 4. Chiton.
Section III. Cruftaceous Worms.			1. Afterias. 2. Echinus.
Section IV. Polypi.	Order I. Naked polypi.		1. Hydra. 2. Urtica Marina.
	Order II. Polypi, in corneous or ligneous cells.		1. Lithophyton. 2. Corallina.
	Order III. Polypi in cretaceous cells.		1. Corallium. 2. Madrepore.
	Order IV. Polypi in foft and fpongy cells.		1. Efchara. 2. Spongia. 3. Alcyonium.

WORMS
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